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RAPID WORK IN RAISING A WRECK was accomplished in the case of the steamer "Rosedale," which was sunk in 16 ft. of water, by a collision in the East River, New York, on Sept. 3. The Chapman Wrecking Co. had the vessel raised within 24 hours after the accident. The "Rosedale" measures 216 ft. over all, 34 ft. beam, 10 ft. draught.

CHAINLESS BICYCLES, in which two pairs of bevel gears are used instead of the chain, are reported to have proved their superiority over the present style of wheel in a test, in which a wheel was run 39,000 miles without adjustment or appreciable wear. Dynamometer tests also show that the bevel gears run with less friction than the chain. It is stated that one of the largest manufacturers will soon put these wheels on the market. An obstacle to their rapid introduction is the time required to construct the machinery necessary for turning out the bevel wheels which must be mathematically accurate in form.

THE NEW YORK & NEW JERSEY BRIDGE CO. held a meeting at 214 Broadway, New York city, last week, at which Gen. J. S. Clarkson was elected President; Louis Windmuller, Vice-President, and Charles H. Swan, Secretary and Treasurer.

FOR THE NORTH SEA AND BALTIC SHIP CANAL a revised tariff of charges on shipping went into operation on Sept. 1. Under the old tariff vessels up to 600 tons net were taxed 60 pfennings, or 15 cts. per ton, and vessels above that tonnage, 40 pfennings, or 10 cts. per ton. Under the new tariff the 10-ct. rate begins with vessels of 400 tons; above 600 tons, the tax is 30 pfennings, or 7½ cts., and beyond 800 tons it is 20 pfennings, or 5 cts. per ton. For vessels empty, or in ballast, the tax is 20% less than the above rates. Besides the above dues sailing vessels using the regulation tugs will be charged as follows: For the first 200 register tons net, 10 cts. per ton; for every additional register ton, 7½ cts. From October to March the charges for tugs will be increased 10%, but these charges include compensation for the use of the entire working arrangement of the canal and for the services of pilots between the ends of the canal.

THE MANCHESTER SHIP CANAL CO. has sent its general manager, Mr. Marshall Stevens, to this country to induce the transportation companies here to make more use of the canal. Mr. Stevens has issued a circular letter setting forth the apparent advantage, at least, of shipping direct to Manchester instead of via Liverpool. He claims that with no reduction upon inland freight in America and with an even sea rate there will be an average saving on the whole New York cargo of 7 cts. per 100 lbs., or $1.56 per ton in favor of Manchester; and $1.17 per ton saving on the New Orleans cargo. He does not explain where this saving comes in, except to say that delivery by cart to destination is included in his figures and that one week is allowed at the Manchester docks for the removal of freight from the quay sheds, as compared with 3 days at Liverpool.

CAST-IRON PROJECTILES are soon to be ordered by the Ordnance Bureau of the War Department, about $50,000 being expended on shells and shrepnel. The latter will be bought for use in the 3.2 and 3.6-in. guns, the projectiles to be fitted with 15 and 28-second fuses. The cast-iron shells are for the siege and seacoast guns; 500 shells of the 7-in. 500-lb. type will be bought for siege projectiles. The shells for use in the seacoast guns are as follows: 100 8-in., 100 10-in., 100 12-in., 100 12-in. 800-lb. mortar, and 50 12-in. 1,000-lb. mortar shells.

ONE OF THE LARGEST GUNS designed in this country is the 16-in. gun which the Watervliet arsenal is now getting ready to build. The United States has built two of larger caliber for its coast defences, but they were old-fashioned 20-in. smooth-bores, 20 ft. long, with a range of between five and six miles. The new gun will be 49.67 ft. long, will have a range of 16 miles and be able to penetrate 27½ ins. of armor at a distance of two miles. The gun will weigh 125 tons, and it will throw a solid armor-piercing projectile weighing 2,370 lbs. The great trouble so far found in the construction of guns of such size has been that they "drooped" at the muzzle after being fired a few times. The Ordnance Board, however, believes that it has succeeded in overcoming this defect. The maximum diameter of the breech of the new gun will be 62 ins., and the diameter of the breech opening 20 ins. To fire this gun will require a charge of 1,000 lbs. of the usual brown prismatic powder.

THE MOST SERIOUS RAILWAY ACCIDENT of the week occurred, Sept. 7, at Taswell, Ind., on the Louisville, Evansville & St. Louis Consolidated R. R. The wrecked train was an excursion from St. Louis. The baggage car and three coaches jumped the track and rolled down an embankment. Ten people were injured, two fatally.

A THRESHING ENGINE BOILER EXPLODED near Sanilac Center, Mich., Sept. 2. It was carrying 100 lbs. pressure at the time. Three men were killed and two injured. Near Charleston, W. Va., on Sept. 2, a saw mill boiler exploded, killing two men and injuring two others.

A FALLING WALL killed eleven firemen at Benton Harbor, Mich., Sept. 6. The Yore Opera House, a four-story brick building, was not discovered to be on fire until the flames had made considerable headway. The wall fell almost as soon as the firemen arrived.

PROPOSALS FOR THE READING SUBWAY (for the depression of the Philadelphia & Reading R. R. tracks) at Philadelphia, were opened Sept. 1, the bidders being Ryan & Kelly, E. D. Smith & Co., P. H. Flynn & Co., Sullivan Bros., Mason, Hoge & Co., and R. A. Malone & Co. The tunnel will extend from 22d St. to Tavey St., 2,710 ft. In this distance there will be 13 openings in the center of the newly-made street. Each opening in the center of the roadway will be surrounded by a stone coping 3 ft. high, over which twining vines will grow. Outside of this will be a plot covered with trees and shrubs, and surrounded with a highly ornamental picket fence. Each plot will take up a space 10 × 48 ft., and in the narrowest part there will be an asphalted roadway on either side, 27 ft. wide, giving a street on either side at least as wide as Chestnut St. The next contract covers that part of the subway beginning east of 22d St. and running to the grade at 30th St., and includes all of the tunnel work and part of the open subway. The original plan required the erection of fan houses by the city for the purpose of expelling the foul gases from the tunnel, but this has been done away with and the new plans call for openings in the tunnel which will be a great saving in the cost of construction. The work has been described and illustrated in our columns.

THE TAMALPAIS MOUNTAIN RAILWAY was opened Aug. 26. The line starts from Mill Valley, Cal., and rises 2,300 ft. in a straight distance of two miles, although the railway is 8¾ miles long, with grades of 5 to 7%. The line is a very winding one, composed mainly of curves and loops, the sharpest curves being of 72 ft. radius.

A RECORD FOR TRAINS RUNNING ON TIME is claimed by the Chesapeake & Ohio Ry. for its four limited trains running between Washington and Cincinnati. Each train covered the distance of 599 miles 122 times during the months of March, April, May and June, and the four trains were on time 463 times out of a possible 488, or 95%.

AIR MOTORS WERE SUCCESSFULLY TESTED on the night of Sept. 3 on the boulevard line of the Third Avenue Railroad in New York. They ran from the Fort Lee ferry across town, back to Tenth Ave. and up the heavy grade on that avenue to Fort George. The cars were stopped and started up and down on the steepest grades.

AN AIR MOTOR capable of pulling a train of five cars is shortly to be tested on the Sixth and Ninth Avenue lines of the New York elevated railroads. The American Air Power Co. which is to furnish the motor, has leased a building at Greenwich and Rector Sts., where the plant for compressing the air is being erected. A pipe will be run from the motor house to the Rector St. station, where the motor will be charged. The motor is being built at the Rome Locomotive Works, and is to be completed by Nov. 1.

THE "FRAM'S" HIGHEST LATITUDE, says Capt. Sverdrup, in his detailed account, was 85° 57' North, in 66° East longitude, reached on Oct. 16, 1895. From this point the "Fram," tightly bedded in the ice, drifted southward. Aside from the fact that this expedition reached a point nearer to the North Pole than any preceding it, is the remarkable behavior of this remarkable ship. Capt. Sverdrup, who succeeded to the command after Capt. Nansen left the ship on his expedition over the ice, says that though the ship was repeatedly subjected to enormous pressure from the ice, she was safely and quietly lifted up without undue strain; sometimes being lifted 6 to 9 ft. several times a day. He reported the expedition as an easy one, resulting in no damage to the ship or to the men.

THE PAVING OF CITY STREETS was referred to in a paper on "Highway Legislation," read before the American Social Science Association, at Saratoga, on Sept. 3, by Prof. Francis Wayland, of Yale. For cities he advocated compelling the street car corporations to pay for keeping a certain space on each side of, as well as between, their rails in good order. This is only equitable, because by diminishing the amount of room which can be used by vehicles they add greatly to the wear and tear of the remainder. It was, moreover, suggested that a tax should be levied on vehicles in proportion to the amount of injury which they were capable of doing in their daily use. There seemed no justice in calling on abutter to pay a considerable part of the expense of repairing a street which would have needed almost no repair but for the damage caused by heavy carts. If the amount of this "wagon tax" were used exclusively for street repairs it would go far toward a reasonable solution of the problem. This expedient has been adopted in other countries with good results.

THE STEEL ARMORED CRUISER "BROOKLYN," in her trial trip of Aug. 27, made an average speed of 21.92 knots in a run of 83 knots, and passed over part of the course at the rate of 22.90 knots per hour. She made the run with a boiler pressure of 160 lbs. and an average of 138 revolutions per minute of the screws, with a maximum of 140 revolutions. By her performance she is claimed to earn a bonus of about $350,000 for her builders, the Messrs. Cramp, of Philadelphia. Her contract speed was 20 knots per hour. The cruiser "New York," on her trial trip, made an average of 21 knots; the "Minneapolis" made 23.073 knots; the "Columbia" made 22.81 knots, and the "Olympia" made an average of 21.69 knots per hour.

THE WIRE FOR THE NEW SUSPENSION BRIDGE over the Ohio River between Cincinnati, O., and Covington, Ky., is now being delivered, and the work of stringing the wires and making the cables will soon be commenced. The wire is of No. 6 gage, and is delivered on large spools.

THE NEW BROOKLYN TIMBER DRY-DOCK, now under construction at the Brooklyn Navy Yard, is to be completed for the government about Nov. 30, next, by the present contractors, T. & A. Walsh. This dock was contracted for originally with John Gillies, and it was to cost $575,000. After no practical progress had been made in two years, it was taken from him and on April 30, 1895, it was awarded to the above contractors, and will now cost, complete, about $650,000. The general dimensions are as follows: Length, 658 ft.; width, 64 ft.; width at entrance, 105 ft.; mean draft at high water, 28 ft. More detailed dimensions are as follows:

	Ft.
Length on coping level	500
Length inside head to inner sill	580
Length inside head to outer gate sill	600
Length inside head to outer end of table	625
Length on floor head to inner abutment	516
Length on floor head to outer gate sill	556
Width on coping on head	94
Width on coping on body	151
Width on coping at abutment	105
Width on coping at entrance	105
Width at entrance on high water line	100
Width of coping at outer end of table	154
Width on floor of dock at head	27
Width on floor of dock at head angles	64
Width on floor of dock in body	64
Width on floor of dock at abutment	64
Width on floor at inner abutment	70
Width on floor at outer end of table	116
Depth from top of coping to mean high water	5
Depth from top of coping to inner abutment floor	33
Depth from top of coping to working floor of dock	35

AN INTERESTING CASE OF CORROSION of the metal of marine engines was described at the recent meeting of the Institution of Mechanical Engineers at Belfast, Ireland. A steamer loaded with "burnt ore" was sunk off the coast of Scotland, and was under water for a week. When the vessel was again floated the machinery was found to present an extraordinary appearance, all wrought iron work being deeply corroded, and planed cast iron being so soft as to be easily cut with a knife. As engines are generally little injured by submergence, even for a considerable time, it was evident that there had been some unusual chemical action. The source of this was found in the cargo, burnt ore being the residue from the manufacture of vitriol from sulphur pyrites, and usually containing sulphates of copper and iron. These salts would react on the chloride of sodium of sea water to form sulphate of sodium and chloride of copper, either of which in solution dissolves wrought iron or cast iron.

AN EXHIBITION OF MACHINERY will be held in Munich in 1898. American manufacturers have been invited to participate, according to a letter from U. S. Consul Steiner to the Department of State.

THE SEWERAGE AND SEWAGE DISPOSAL SYSTEMS OF PLAINFIELD, N. J.

By Andrew J. Gavett, Constructing Engineer.

The city of Plainfield, N J., is situated in the western corner of Union Co., hemmed in on two sides by the counties of Somerset and Middlesex. On the Somerset Co. side, only separated from the city by a narrow brook, is the borough of North Plainfield, and its interests are identified in many ways with those of the city.

The population of Plainfield is now about 13,500, that of North Plainfield 3,500. Such a large proportion of the residents of both places are New York business men that the chief occupation of the people is said to be "going to New York."

An excellent water supply system, pumping from wells in the eastern part of the city to a stand-pipe 140 ft. high, has been in use a number of years, but this has only emphasized the urgent need of a system of sewers. The poorer buildings are supplied with outhouses having leaching vaults, and cesspools, also leaching, for sink wastes. The better class of buildings generally have complete and often costly systems of plumbing, but all draining into cesspools on the premises. These were emptied from time to time by "odorless" excavating carts, and the expense of this work was no doubt very much greater than all the extra taxes and interest on the assessments for the sewerage system will be.

Topography.

Geologically and topographically, Plainfield has the ice age to thank for her formation. From 40 to 70 ft. below the present level of the city is the Triassic red sandstone and shale; across the eastern end of the city stretches the terminal moraine of the ice sheet, while the underwash from the glacier forms the site of the city. These details are given as they indicate with considerable exactness the character of the material encountered in the construction of the sewerage system and that of the disposal beds as well. The latter are situated in that part of the city farthest from the moraine.

Sewer trenches in the moraine disclose an unstratified mixture of clay, gravel, hardpan, and occasional large boulders. Going west, and descending, a coarse gravel is first found, then stratified sands and gravel, followed by sand alone. The city is underlaid by a flowing sheet of water of great purity and abundance, which furnishes the water supply of the city. At the pumping station the surface of the water is 18½ ft. below the surface of the ground, and it falls toward the southwest at a rate of about 1 in 300, the average inclination of the surface of the ground. At Grant Ave. and Front St. the water was found just below the sewer at a depth of 4 ft., and in the 14-ft. cut at the corner of Central Ave. and Eighth St. the water was also found a few inches below the sewer. But in Ninth and Richmond Sts. the sewer grade was from 6 to 24 ins. below the water level, and the very free flow of water, coming through the open sand and gravel, caused the contractors considerable difficulty and delay.

In all other parts of the city, however, the conditions encountered were extremely favorable, the material being dry and easily handled, no sheeting being required in the more shallow trenches. These conditions explain the very low prices at which the different contracts were let.

Preliminary Work.

The first move for sewers which yielded practical results was made in 1892, when a committee, composed of representative citizens and members of the common council, was appointed by the Mayor, Mr. Alexander Gilbert.

After a thorough investigation and discussion of various methods of disposal, including the popular one of emptying into the Raritan River (for which surveys were made for the committee by Mr. F. A. Dunham, C. E.), the committee reported the estimated cost of several methods of disposal, favoring the plan of intermittent filtration. The report, which included profiles and estimates for the various schemes under consideration, as well as proposed methods of assessment and the providing of funds for the prosecution of the work, was presented to the common council on March 6, 1893, and adopted.

After a careful investigation by the Corporation Counsel, he advised proceeding under the Act of April 7, 1890, which directs that upon the petition of the owners of three-fifths of the real estate valuation of the city, the council shall be empowered to proceed with the construction of a sewer system, issuing, from time to time, temporary obligations of the city in payment for the work, and when completed, commissioners shall be appointed, whose duty it shall be to assess the benefits upon the property benefited, and the excess shall be assessed upon the city at large, and for this excess, bonds shall be issued.

On April 4, 1893, the council decided to proceed under this act, and the work of securing the signatures of the owners of a sufficient valuation was begun. Volunteers made house to house visitations, with copies of the assessor's lists of property-owners, through the remainder of the year 1893 and well into 1894, before the requisite amount was secured.

A general ordinance, specifying all the streets in which it was supposed that sewers would be required, was adopted by the common council on July 25, 1894. Pending the passage of this ordinance, considerable work was done by Mr. George H. Frost, of the sewer committee, in planning the routes for the main sewers, and preliminary levels were run for this purpose by Mr. F. J. Hubbard.

At a meeting held Aug. 6, 1894, the following appointments were made: Committee on Sewers, Messrs. George H. Frost, E. N. Erickson,* S. A. Ginna; Consulting Engineer, F. W. Farquhar, of New York; Constructing Engineer, A. J. Gavett; Assistant Engineers, F. J. Hubbard and H. C. Van Emburgh.

Plans were at once prepared on the lines laid out by Mr. Frost, and on Sept. 10, 1894, the first contract for 5.2 miles of sewers, mostly mains, was let. The first work was begun on Sept. 24, and prosecuted until stopped by cold weather on Dec. 24. During the progress of this work, levels were run over the entire city and a general drainage plan, with profiles, was completed, showing the location and grade of a complete sewer system.

All storm water is excluded from the sewers and flushing is provided for by automatic flush tanks at the head of each sewer. The surface water is carried in the gutters of the streets, directly to the two brooks, or to storm sewers emptying into them. Other storm sewers are planned for future construction, but not many are required, and they will be short ones, from 12 to 24 ins. in diameter. The two brooks are named Green and Cedar, and flow through the entire length of the city, about ¾-mile apart.

Plans for Disposal.

During the winter, the matter of sewage disposal was taken up for final settlement, and estimates of the cost of the various plans which had been under consideration were submitted by Consulting Engineer Farquhar, with the result that all schemes for reaching tidewater were abandoned on account of the great difficulties involved, and the danger of legal complications.

This narrowed the question down to the choice of one of two locations for the disposal beds. One was near Sebring's Mills, a mile below Dunellen, the other in the western corner of the city, 2½ miles nearer the lateral sewer system than the former. Although the Sebring's Mills location

*Upon Mr. Erickson's retirement from the council in December, 1895, Mr. J. B. Dumont succeeded him as a member of the committee on sewers.

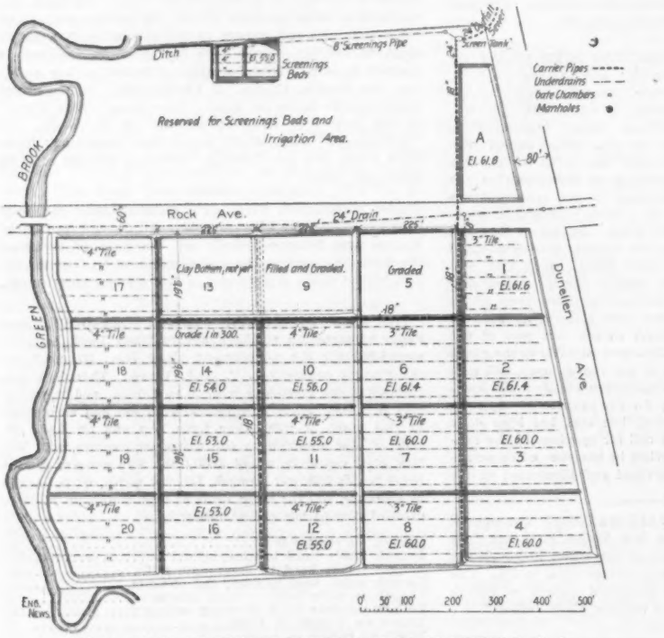

FIG. 1.—PLAN OF SEWAGE DISPOSAL AREA, PLAINFIELD, N. J.

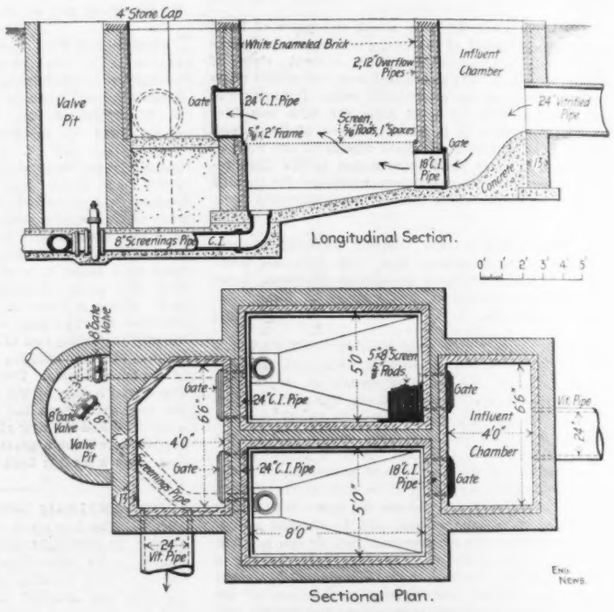

FIG. 4.—DETAILS OF SCREEN CHAMBER.

possessed a number of advantages, no action could be taken toward securing it for disposal purposes without the consent of the authorities of Piscataway Township, and this consent being refused, the Plainfield site was necessarily decided upon.

The land finally selected lies at an elevation of from 50 to 72 ft. above mean sea level, so that most of the city can be drained to it without pumping. For the most important outlying district, the Cedar Brook Valley, a system has been

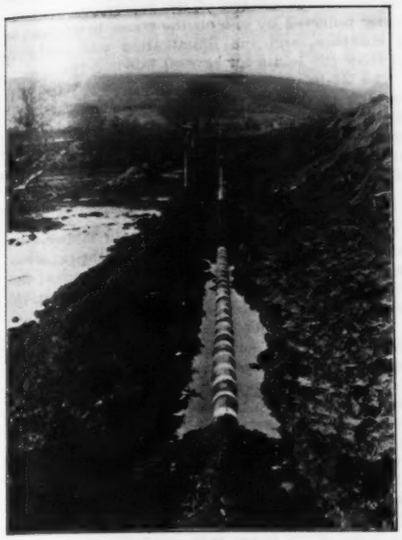

Fig. 2.—View of 4-in. Underdrain in Bed No. 10, During Construction.

designed for future construction, draining to a pump well near the junction of Plainfield and Pemberton Aves., from whence it is proposed to raise the sewage by automatic, electric pumps, through a 10-in. cast-iron force main, 1,000 ft. long, into a gravity sewer at Grant and Sherman Avs.

Grades.

In order to drain the largest possible area to the disposal beds by gravity, the main sewers have been designed with minimum self-cleansing grades, as follows: For 24-in. sewers, 1 in 1,200; 18-in., 1 in 900; 15-in., 1 in 750; and 12-in., 1 in 600. The 10-in. sewers, and a few of the 8-in. have grades of 1 in 400, but the most of the 8-in. laterals have inclinations of 1 in 300 or more.

Outfall Sewer.

The main outfall sewer is 7,726 ft. in length, from Grant Ave. and Third St. to the screening tank. It is constructed of 24-in. vitrified pipe 1⅝ in. thick, laid on a grade of 1 in 1,200. The greatest depth of cut was 18½ ft., and a length of 2,540 ft. was over 16 ft. deep. At one point it was but 4 ft. deep.

Wherever the cut was less than 5 or more than 15 ft. a concrete foundation and backing was used. A bed of 4 ins. of concrete was first laid and the pipe was then bedded in stiff mortar; when correctly graded and lined, concrete was rammed under and on each side of the pipe. After the concrete had set, the inside joints were cemented on the bottom and more than half way up each side.

Some difficulty was experienced in excavating the trench in the deep cuts, as the sand dried so quickly that it ran out under and between the sheeting planks, loosening the cross braces and causing a cave-in several times, but without serious results. No water was encountered, and where the sheeting was carefully done, the work was ideal for cleanliness and comfort.

Main Sewers.

At Grant Ave. and Third St. the north and south mains enter the outfall sewer. They are respectively of 15 and 18 ins. diameter and the cuts run from 4½ to 14 ft. deep. After traversing circuitous routes and separating some 3,300 ft., they nearly meet again, as 10-in. sewers, on Richmond St.

Lateral Sewers.

The streets running transversely to the main sewers are almost level, and in the center of the city the blocks are generally about 300 ft. square. In order to avoid using an excessive number of flush tanks, which would have been necessary otherwise, many of the cross sewers are continuous for several blocks, crossing the other sewers without connecting.

The necessity of providing sufficient clearance for the different crossings required some sewers to be deeper and others more shallow than the usual depth of about 7½ ft. A 6-ft. length of cast-iron water pipe was used for the upper sewer at all crossings, to prevent settlement.

The least depth of sewers was generally at the flush tanks, in some cases slightly under 5 ft.; the greatest depth, except on the outfall sewer, was 14 ft.

The lines and grades of all sewers were so established that a clear line of sight may be obtained through every part of them, by sighting from one manhole to another, or from manhole to lamphole.

The establishment of this full bore line of sight was one of the requirements of the contracts, but the contractors really had very little to do with securing it, as the inspectors handled the grade rods and plumb lines and were made responsible for accurate work.

Y-Branches and Extensions.

Four-inch Y-branches were located at the most convenient point for each building and wherever else it was thought they would ever be needed, the distances apart varying from 10 to 75 ft. Where the sewers were deep, an extension connection was constructed, consisting of an eighth bend, turned upward, supported by a 12-in. brick pier, with a 2-ft. length of 4-in. pipe added. On the outfall sewer, where the depth would allow, 6-in. T-branches were used on the 24-in. pipe. They were turned upward and were surmounted by a 6×4-in. double Y-branch, the branches being turned toward the sides of the street. As the depth increased, lengths of 6-in. pipe were used to raise the double branch to a nearly uniform depth below the surface. In the more shallow cuts, 4-in. Y-branches were used.

Flush Tanks.

Every lateral sewer is provided with an automatic flush tank at its upper end (except where the sewers are soon to be extended) and little or no hose flushing will probably be needed after the house connections are generally made. The flush tanks are 43 ins. in diameter and of 150 gallons capacity. At first they were set to discharge once in 12 hours but they are now regulated for emptying once in 24 hours. The siphons are of three kinds, Rhoads-Williams, Miller and Van Vranken. A lamphole is constructed adjoining the flush tank and is connected with it by a 6-in. pipe. It is believed that, with occasional inspection, the flush tanks can be trusted to do their work with more certainty, regularity and economy than could be obtained by any system of hand flushing.

The regularity of discharge of the flush tanks is being tested by suspending a "Bristol" counter in the neck of the tank, with a wooden float suspended from the arm. This registers each time the siphon discharges and indicates any failure of the tank to work properly. It will also give assurance to the water company that the tanks are not using more water than is agreed upon. The city pays for the water at the rate of 10 cts. per 1,000 gallons, or about $30 per month at present. In case any flushing with fire hose is needed, it is paid for at the rate of $1 per hour.

In order to ascertain the need and efficiency of the flush tanks, some of them have been shut off for four or five days, and then, when they were turned on again, the flow in the next lower manhole was observed. This experiment showed that the sewers would not keep clean at their upper ends without flushing, as the stream came down black with deposits; also, that the flush-tanks obviated the difficulty, for the last part of the flow ran clear.

It is probable that flushing by hand at considerable intervals would serve to keep the sewers in condition for use, but with disposal beds within the city limits, and in close proximity to dwellings, the periodic washing out of decomposed matter from the sewers would be highly objectionable.

Manholes.

On the main sewers, manholes are placed at all junction points and at all changes of direction or grade, and in general, at distances of from 400 to 500 ft. apart. On the lateral sewers this distance is increased to about 700 ft., lampholes being placed at intervals of 200 to 300 ft. between the manholes. Junction manholes were made 4½ ft. in diameter and intermediate ones 3½ × 4½ ft. in plan. The walls were carried up plumb 3½ ft. and then drawn in to a 2-ft. neck in the next 2½ ft. The walls were 8 ins. in thickness, except where the manholes were over 12 ft. deep, when the thickness was increased to 12 ins.

Each lateral sewer, where possible, has a drop into the main sewer equal to the semi-diameter of the latter. Where underdrains were laid with the sewers, an inspection opening was left over the drain in each manhole, the opening being in the platform at one side of the sewer. Stone covers are placed over the openings, and will be cemented on should it be found necessary.

Provision is made for turning the underdrain water into the sewer for flushing purposes, by plugging the drain below the inspection opening and allowing the water to flow through a side

FIG. 3.—VIEW OF SCREEN CHAMBER AT DISPOSAL AREA.

opening, into the sewer. When not used for flushing, the underdrain water empties, through two outlets, into Cedar Brook.

Underdrains.

Underdrains are laid in East Ninth and Richmond Sts., in part of Watchung Ave., and in most of the Netherwood district. The sizes are from 3 to 6 ins., with a short section of 8-in. outlet pipe. Hub and spigot vitrified pipe was used for the larger sizes, and agricultural tile for the 3-in. and most of the 4-in.; the underdrains were generally laid 9 ins. below the sewer, and the same distance to the left (going up the sewer).

The drains in the Netherwood section are doing good work, but those in the Cedar Brook Valley

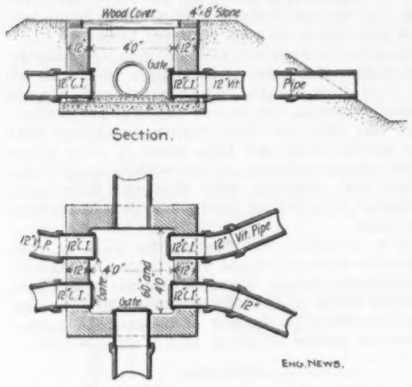

Fig. 5.—Details of Distributing Chambers at Disposal Area.

are entirely submerged in the ground water every spring, and then only serve as outlets for the Netherwood drains.

Materials.

All pipe used in the sewers was from the Ohio Valley, but Akron pipe is being largely used for the 4-in. house connections. All the pipes were in 3-ft. lengths except the 4 and 24-in., which were 2 ft. long.

A careful inspection of the sewer pipe was made at the car while it was being unloaded, and a large quantity was rejected, much of it for crookedness. A regular inspector was detailed for this work, and the payment for pipe was made by the contractor on his reports.

"Hoffman" and "Newark" Rosendale cements were used for all work, and gave entire satisfaction. The specifications called for a cement equal to the "Hoffman" Rosendale, and the contractors decided to use this cement. As its quality was so well known, it was not thought necessary for the city to purchase a cement testing machine, but as a check on the contractors, the constructing engineer had briquettes made occasionally in a standard Riehle mould, and broke them on his own machine, a frame with two levers and 100-lb. spring balance, testing up to 500 lbs.

The cement was used neat, mixed to a stiff paste, for jointing the pipes, and 1 to 1 for mortar for brickwork. Wherever the sewers have since been uncovered, the joints have been found hard and in good condition.

Pipe-laying.

As each pipe was laid, the grade was given by the inspector, using a grade rod with iron shoe reaching into the pipe. A light grade line (braided fish line) was stretched tightly between boards clamped on iron posts. The grade was marked by the engineer on these posts, levels being run each day for the purpose. The iron posts were about $1\frac{1}{2} \times \frac{1}{4}$-in. in section and ordinary cast-iron clamps were used; they were found more convenient than wooden posts, being easily driven and much less liable to wedge off the banks of the trench. They are easily marked with a slate pencil or piece of roofing slate. The inspector kept the pipes in line by plumbing down from the grade line, which was centered on the boards by measuring out from the 4-ft. offset stakes.

A gasket of jute was placed around the spigot end of the pipe before it was lowered into the trench, and the jute was calked into the joint before the latter was cemented. Unless the work was watched, the jute would not be calked into the joint at all, and the cement would be merely beveled over the outside. The other extreme, of having the gasket too small, was also to be guarded against, the general tendency being to use too little jute. The joint room would then be very large on top, sometimes allowing the jute to slip off the end of the pipe and the cement to intrude. The cement was applied to the joints with rubber mittens, being pressed well into the bells, leaving a bevel of cement on the outside.

After a section was cemented, each joint was examined by the inspector, who was also required to see that the earth was solidly packed around the pipe.

The inspectors made daily reports on printed blanks, recording the progress made and force employed, also the location of the Y-branches. These Y notes were recorded the following day on maps drawn to a scale of 1 in. to 100 ft.

Backfilling and Consolidating Ditches.

The backfilling, except the first covering of the pipe, was done by means of horse scrapers. After filling 3 or 4 ft. in this way the trench was flooded several feet deep with water from a fire hose and the material was dragged by the scrapers into the water. By this means the sand and gravel were so well deposited and settled, that when trenches were afterward excavated crossing those filled in this manner, the latter could hardly be distinguished from the undisturbed material adjoining, except in the lower part of the ditch, where the earth had not been consolidated by falling in the water.

The contractors at first paid the water company $1 per day for flushing trenches, the number not to exceed three at a time; this price was afterward doubled, but even then it was the most economical method for the contractor, and more satisfactory to the city than hand ramming would have been.

Testing.

After completion, all sewers (excepting the 24-in. and those where no water could be obtained) were tested by the contractor, in presence of an engineer or inspector, by flushing wooden balls through them by means of streams of water from hydrants.

The balls used were of 2 ins. less diameter than the sewers for which they were intended, and were drilled to receive a cord. This cord was long enough to reach between manholes on main sewers and between lampholes and manholes on laterals. By working the ball back and forth, stones, gravel and even whole bricks were forced through the sewer to the next manhole below.

A wire screen of ¼-in. mesh was always placed in the lower manhole, in order to intercept all debris.

At the time of making the test all manholes, lampholes and flush tanks were examined to see that they were complete and in good order, and the flush tanks were filled and discharged. Notes were made of all defects found, and the inspector went around with the masons later to see that the repairs were properly made.

Many of the flush tanks were tested by filling them to nearly their discharging height, and then leaving them filled for several days. As the mains were tested before the lateral sewers were constructed, the testing of the latter brought more sand down into the mains, which were again cleared by flushing the balls through them.

Considerable use was made of small mirrors in examining the interior of the sewers, the sunlight being reflected by one on the street to another in a manhole, and the illumination was sufficient to show the joints for several hundred feet.

The 24-in. outfall sewer was cleaned by men passing through it, the inspectors following with lanterns. This important sewer was found in excellent condition, and showed the care taken in its construction by the contractor, Mr. John Marsden, of Utica, N. Y.

House Connections to Curb.

On July 20, 1895, the contract for laying 4-in. house connections from the sewer to the curb was executed, with Mr. John Siddall as contractor, and work was prosecuted whenever the weather would permit, until their completion, about May 1, 1896.

The work was let at an exceedingly low rate, viz., from 19 cts. per ft. for work in streets with car tracks and telford-macadam pavement, to 14 cts. in unpaved streets. The contractor has, however, put in many private connections from the curb to the buildings for about 30 cts per ft., and so has been compensated, partly, at least, for his low price on the city work.

Before commencing this work on any street, the owners were interviewed again as to their choice of location for the connection at the curb line. The connections to the curb are laid on a grade of 1 in 48; between the curb and the house much steeper grades are often used, though some of the residences are so far back from the street, with fixtures in deep cellars, that only the flattest allowable grades can be used.

The inspector examined the work, recorded the length of the connection, the number of the house, and the distance from the end of the connection at the curb to the line of one side of the building pro-

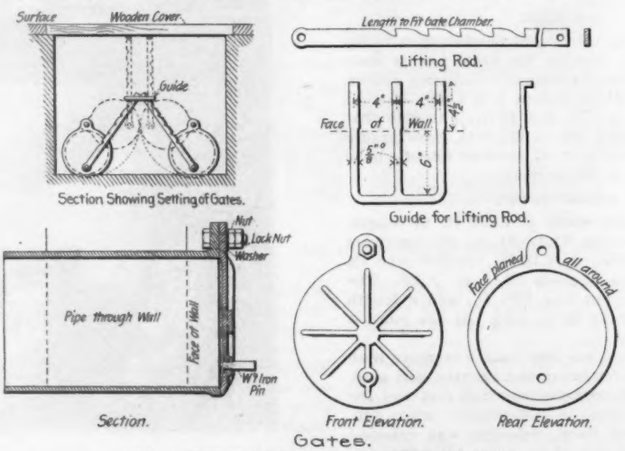

FIG. 6.—DETAILS OF GATES AT DISPOSAL AREA.

duced. Where there was a curbstone, a V was cut on it over the end of the pipe; in other places a stake was driven.

Ventilation.

The plumbing ordinance of the board of health requires that every plumbing system must be provided with a ventilating pipe extending above the roof, clear, and 4 ins. in diameter. In some cases this is secured by a separate 4-in. pipe carried above the roof from the sewer side of the trap on the main drain, but in most cases the trap is omitted, and the ventilation is secured through the soil pipe.

A Gas Explosion.

On Thanksgiving day, 1895, an explosion of illuminating gas occurred, which did considerable damage to the sewers and appurtenances. A 4-in.

gas main in Richmond St. was broken by some unknown means, and the break was not discovered for several days. The gas found its way to the manholes through the open joints of the 6-in. underdrains, and thence spread through the sewers in that vicinity. It was lighted by a property-owner on La Grande Av., who had a house connection pipe laid into his cellar, but not connected to the plumbing system. Smelling gas in the house, and being of an inquiring turn of mind, he investigated the matter with a light, and a number of explosions occurred in rapid succession, as manhole and lamphole covers were blown high in air, the effect reaching a distance of three-quarters of a mile.

Upon examination, some of the manholes were found cracked, and one of the lampholes was shattered. An examination of the sewers with mirrors and a test with balls failed to show any further damage, but by digging down to the sewer two other injured portions were discovered, one of about 60 ft. in the 12-in. sewer in Richmond

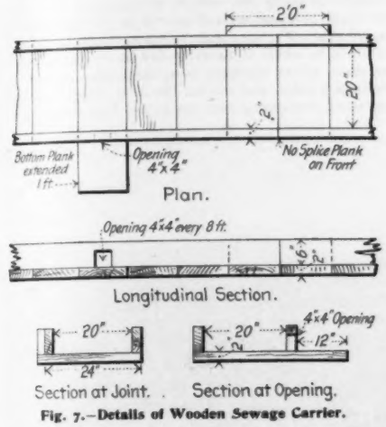

Fig. 7.—Details of Wooden Sewage Carrier.

St., and the other of 164 ft. in Putnam Ave., near Richmond St. The pipes were found cracked longitudinally, but none of the pieces was displaced.

Disposal Beds.

The outfall sewer reaches the beds, shown by Fig. 1, at an elevation of 63½ ft. above mean sea level, and the grades of the upper beds vary from 61.8 to 60.0, the latter being the ones most distant from the sewer. The elevation of the lower tiers of beds is about 5 ft. less.

The land purchased for the disposal beds comprises three farms of about 17 acres each, bounded at one end by Front St., the main thoroughfare from Plainfield to Dunellen and Bound Brook, and at the other end by Green Brook, the city and county line. The property is intersected by Dunellen Ave., parallel with Front St. and Green Brook, and by Rock Ave. transversely, both public roads.

At present only the two tracts nearest the brook are being graded for beds; the remainder, containing two roomy and substantial houses, is being farmed.

To bring the upper beds to the required grade for delivering the sewage on them by gravity, necessitated the excavation of nearly 60,000 cu. yds. of sand, the deepest cut being 10 ft. About 26,000 cu. yds. were excavated from the beds east of Rock Ave., and the material so excavated was deposited in the lower beds, the grade of which was made as low as the flood level of the brook would warrant.

Mr. Allen Hazen, of Boston, who had been engaged by the common council to report on the availability of the materials in the disposal bed area for the purpose intended, advised that the different grades of sand should be kept separate in filling, the experiments at Lawrence having indicated the danger of placing layers of coarse sand over fine, an impervious layer being formed at the junction. For a similar reason the surface of the beds, when above sub-grade, was ploughed and kept loosened as the fill was made over it.

The top soil, to a depth of at least 1 ft., following the slope down to sub-grade, was removed and placed in the embankments.

In excavating the top-soil, and wherever the haul was short, slip and wheeled scrapers were used, but in the deeper cuts the excavation was made by a steam shovel. West of Rock Ave., a continuous line of carts moved the sand from the shovel to the lower beds; east of Rock Ave., dump cars and a light construction track were used to good advantage.

Underdrains were laid under each bed, 39.2 ft. apart, and from 5 to 7 ft. deep, the grade being 1 in 300.

In the upper beds 3-in. agricultural tile was used, emptying into manholes constructed of 24-in. vitrified pipe. From these manholes, 4-in. tiles continue under the lower beds to the brook, terminating in 12-ft. lengths of cast-iron water pipe.

TABLE I.—Contract Prices for the Plainfield Sewerage System.

John Marsden's Contract.

	Depth, ft.					
	Under 8	8—10	10—12	12—14	14—16	16—18½
24-in. sewer ..	$1.28	$1.30	$1.50	$1.65	$1.90	$2.28
Manholes	30.00	32.00	35.00	36.00	40.00	45.00

Y and T branches, $2.30 each; double 6 × 4-in. branches, 50 cts.; 6-in. pipe extensions, 12 cts. per ft.; concrete foundation and backing, 20 cts. per lin. ft.

W. W. Cook & Co.'s Contract.

	Depth, ft.				
	Under 8.	8—10	10—12	12—14	Y bnchs.
18-in. sewer	.....	$0.80	$0.90	$1.10	$1.00
15-in. "	$0.54	.60	.70	.93	.75
12-in "	.45	.50	.55	.70	.40
10-in. "	...	.45	.50	...	.38
8-in. "	.28	.35	.40	...	.27

M. Honan & Son's Contract.

24-in. sewer	$1.27	$1.40	$1.51	.....	.....
12-in. "	.47	.54	.....	.....	.....
10-in. "	.41	.44	.48	.56	.....
8-in. "	.29	.32	.42	.52	.....
Junct'n manholes	30.50	32.50	35.00	.....	.....
Plain "	29.00	31.00	33.00	36.00	.....

8-in. drop connections, each	$1.50
Cast-iron pipe sewer, 8 to 12-in., per ft.	2.00
Lampholes, each	7.00
Flush tanks, each	70.00
Y branches on 24-in. sewers, each	2.50
" " " 12-in. " "	.55
" " " 10-in. " "	.35
" " " 8-in. " "	.25
Extensions on same, extra, each	.90
3-in. underdrains, per ft.	.07
4-in. " " "	.09
6-in. " " "	.13

Extra Work—Fixed Prices.

Extra concrete, per cu. yd.	$5.00
Rock excavation, per cu. yd.	3.00
Sheeting or shoring ordered left in place, M. ft.	20.00
Gravel foundation, per cu. yd.	.75

Disposal Beds—Washburn & Washburn, Contractors.

Excavation, low lands to sub-grade, per cu. yd.	$0.125
Excavation—General, per cu. yd.	.17
Overhaul, per cu. yd.	.06
Screening tank, cost, complete	977.76
Gate chambers, 4 × 6 ft.	60.00
" " 4 × 4 ft.	50.00
18-in. gates—extra, each	15.00
12-in. gates—extra, each	6.00
18-in. sewer in embankment, per ft.	.66
12-in. pipe outlets from gate-chambers, per ft.	.55
3-in. tile underdrains, per ft.	.15
4-in. tile underdrains, per ft.	.10

Note.—Excavation for 4-in. drains was about 18 ins.; for 3-in. drains, about 6 ft.; manholes (of 24-in. pipe—over underdrains), $20 each; wood distributing channels, tarring extra, 28 cts. per lin. ft.

For a distance of 25 ft. above the manholes, the drains are composed of 4-in. vitrified pipe, laid with cemented joints, to prevent the water from the upper beds from leaching through to the lower.

The drop from one level of the underdrains to the other is made in the manholes; these manholes prove convenient for obtaining samples of the effluent as well as for examining the drains. In bed No. 11, where the material was extremely fine, an extra drain was laid between each of the others. While the underdrain ditches were being excavated, samples of the materials were taken at frequent intervals and kept in numbered bottles; the notes thus obtained were transferred to the profiles of the drains, making an accurate record of the original materials in each bed, which range from coarse to very fine.

The excavated sand which has been filled into the lower beds runs much more even in size than the test pits indicated, so that, while the specifications classified the materials as "fine," "medium" and "coarse" sand, only one bed, No. 12, has been entirely filled with coarse sand, * and one bed, No. 11, naturally fine, has been leveled up with fine sand. The remaining sand is quite uniformly "medium," and the operation of excavating by the steam shovel, emptying into carts and dumping into the fill, served to thoroughly mix any thin layers of fine sand encountered. The medium sand is about 0.20 to 0.25 mm. (0.008 to 0.01 ins.) effective size.

The ordinary dividing embankments between the beds are 2 ft. high and 2 ft. wide on top, with slopes of 1½ to 1; the embankments containing the carrier pipes are 4 ft. wide on top and about 4½ ft. high; those serving as roadways are made 10 ft. wide on top.

Enough of these roadways are provided to give access to all the beds. Along the brook the roadway embankment becomes a levee, which was mainly formed from the stiff clay found in excavating the beds along the brook to sub-grade. The amount of excavation required to bring the lower beds to sub-grade was 5,875 cu. yds.

Contract Prices.

The contract prices for the various parts of the work are given in Table I., and some facts regarding the several contracts in Table II.

Screen Chambers.

The 24-in. outfall sewer terminates, with a curve of 79 ft. radius, in the screen chambers shown on the plan, Fig. 1, and by the view and the details, Figs. 3 and 4, respectively. The sewage is admitted from the influent chamber to either of the two 5 × 8-ft. screen chambers through the 18-in. gates. At first, when the quantity of sewage was very small, both these gates were kept closed until the sewage filled the 24-in. pipe, when the 28,000 gallons thus stored up were run out upon the beds. At present the sewage is allowed to flow continuously through one or the other of the screen chambers, where the sewage rises through the screens, and flows out through the 24-in. gates to the main carrier pipes. The screens are constructed of ⅝-in. galvanized wrought-iron bars, spaced 1 in. apart in the clear, are submerged 0.3 ft., when in use, and can be removed if required.

The entire interior of the screen tank is lined with imported, white enamelled brick, coped with

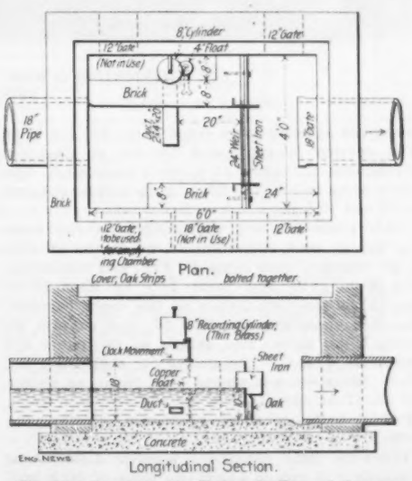

Fig. 10.—Apparatus for Gaging the Flow of Sewage

TABLE II.—Details of the Several Contracts for the Plainfield Sewerage System.

Contractor.	Contract executed.	Work finished.	Character of work.	Total amount.
W. W. Cook & Co., Jamestown, N. Y.	Sept. 14, 1894.	June 1, 1895.	Mostly mains.	$19,608
M. Honan & Sons, Chester, Pa.	April 5, 1895.	Nov. 22, 1895.	Mostly latera'ls.	43,190
John Marsden, Utica, N. Y.	July 10, 1895.	Nov. 15, 1895.	Outfall sewer.	13,653
John Siddall, Trenton, N. J.	July 20, 1895.	May 15, 1896.	House connect'ns.	5,529
Washburn & Washburn, New York	Oct. 10, 1895.	July 1, 1896.	Disposal beds.	31,212

*Effective size about 0.30 mm. (0.012-in.)

bluestone. The tank is covered by a frame building.

The two chambers are intended to be used alternately, to allow of cleaning one while the other is in operation. The screen chambers are each provided with an 8-in. cast-iron drainage pipe with gate valve, the two pipes converging to a cast iron Y-branch, and then continuing, by an 8-in. vitrified pipe, to the screenings beds on the low land.

The two screenings beds, or sludge beds, are each 75 ft. square, and are located on the swampy land east of Rock Ave.

Sand was excavated from the adjacent hill, and filled to a depth of about 4 ft., to form the beds. Four-inch tile underdrains are laid under the beds, emptying into ditches leading to the brook. These drains are intended to form part of the system of underdrains for the beds east of Rock Ave., when they are needed. The screenings beds may be moved nearer the brook when the area now occupied is needed for filtration beds.

About every three days the screenings are flushed out of the chambers onto these beds, and after the material is sufficiently dry, it is raked up and carted to the farm for fertilizer; this amounts to two or three cart loads each week.

The main carrier pipe is 24 ins. in diameter to the first gate chamber, where it is reduced to 18 ins.; an 18-in. gate is provided at this point for use when the easterly farm tract is graded for beds. The carrier is continued 18 ins. in diameter throughout the work at present completed. The pipes to be laid in the lower beds will be reduced to 15 and 12 ins.

Gate chambers are constructed on the main carriers at each embankment, as shown by Fig. 5, the ordinary ones being 4×4 ft., and containing one 18-in. gate and from two to four 12-in. gates. At junction points of the main carriers, the gate chambers are 4×6 ft., and contain an extra 18-in. gate. The details of the gates are shown by Fig. 6. The guides for sustaining the 18-in. gates are not placed over them, as shown for the 12-in. gates, but in the adjacent side walls, in order to allow more room for opening the gates.

From the gate chambers wooden distributing channels will extend along two sides of each bed, and a few are now in position.

They are constructed, as shown by Fig. 1, of 2-in. spruce planks, are 20 ins. wide in the clear, the sides 6 ins. high (except the section nearest the gate chamber, which is 12 ins. deep) and the bottom planks are 24 ins. long, spiked to the side pieces.

Openings 4×4 ins. are provided every 8 ft., and at each opening the bottom plank is extended 12 ins. to spread the flow. Before being used, the channels are covered, inside and out, with coal tar, applied hot.

These tarred distributing channels do not retain accumulations of any kind and give entire satisfaction.

Messrs. Washburn & Washburn, the contractors for constructing the disposal beds, had a large and complete plant and a very efficient force. All their work was done in the most conscientious and satisfactory manner.

Operation.

On December 31, 1895, permission was given to make connections with the sewers, the immediate cause for action at that time being an injunction by the Supreme Court restraining the residents of North Ave. from draining into a storm sewer which emptied into Green Brook. It was supposed that not many others would connect, but 88 applications were received in January, and by the end of April about 450 permits had been granted. All this was before a single bed had been completed, and when but four could be used at all. Up to July 1, 1896, 550 permits had been issued. Eight beds, Nos. 1 to 8, are now planted with corn, in rows 4½ ft. apart. These beds are irrigated about every three days, and the corn is in fine condition, promising a good crop. Two views of Bed No. 8, taken one in June and the other in July, are shown by Figs. 8 and 9.

The beds were planted at different times, as fast as they were finished by the contractors, so the corn varies from that which is "tasseling out" to that only a few inches high. Of course, the corn has no nourishment except the sewage, as the beds were clean sand before use.

The remaining beds, Nos. 10, 11, 12, 14, 15, 16 and 20 are used as filtration beds, being flowed whenever the sewage is not needed on the corn beds.

There is more scum left on the beds than is found in places where the sand is coarser (as at So. Framingham and Marlborough, Mass.), but this dries up without any offense, unless the ground settles, and the sewage "ponds," when considerable odor is caused before the thick deposit dries up. To obviate this trouble the beds are leveled up occasionally by means of a road scraper and rakes, and the aim is to keep the surface as even as possible.

There was a great deal of opposition expressed by the neighboring owners, when the proposal was made to locate the beds so near their property and dwellings, and every odor has been noted and complained of by these men, who make almost daily inspections.

It is probable, however, that the principal objection to the beds is the name of having them located in the vicinity of the property in question, as the odor rarely reaches beyond the beds, and is seldom offensive there.

The completed system includes 23.65 miles of sewers (not including pipes at disposal beds); also over six miles of house connections to the curbs; all of the best materials, and constructed in the most careful manner. These have cost, with all appurtenances and expenses, and with fifty acres of good land, and two good residences about $160,000.

The weir and recording device shown by Fig. 10 has recently been placed in one of the 4 × 6 ft. gate chambers. The apparatus is similar to that at Brockton, Mass.

The float is of copper, 4 ins. in diameter, and weighted with lead. The recording cylinder is made of thin brass, and revolves once in 24 hours. The pen is a V-shaped trough attached to the float spindle by a light steel spring. Dr. Draper's thermograph ink is used. The head on the weir is read occasionally by means of the hook gage to check the diagram.

The flow at present is about 11,000 to 13,000 gallons per hour from 11 a. m. to 7 p. m., diminishing to 5,000 about 4 a. m., and beginning to increase again about 7 a. m. The total for 24 hours is about 230,000 gallons.

It is said that the Pond Machine Tool Co. furnishes between 50,000 and 100,000 gallons of water per day. The remainder would amount to about 55 gallons per head, allowing five persons to each building connected with the sewers.

FIG. 8.—IRRIGATING IN JUNE.

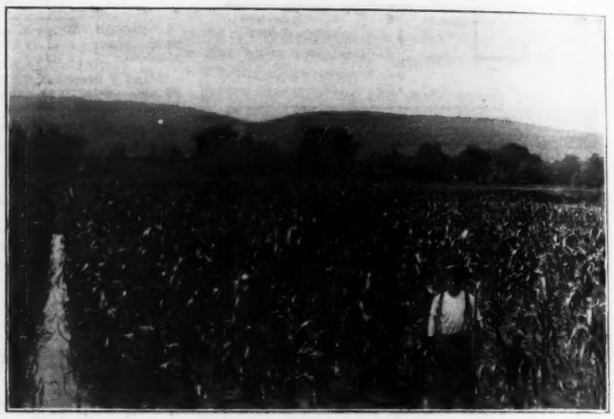

FIG. 9.—CORN IN JULY.

FIGS. 8 AND 9.—VIEWS SHOWING CORN GROWING ON BED NO. 8.

THE ARTISTIC ELEMENT IN ENGINEERING.*

That the artistic element is not recognized as it might or ought to be in the present American day is natural. The rapid development and growth of our land, the intensive study of science and the concentration of the effort put forth to adapt it to every-day affairs, have exalted one phase of the economic idea, the quick attainment of profitable results, and clouded the truer, broader meaning that looks toward the best things and the highest life of the people. Into the midst of this active, restless, business life entered the engineer, doing more and more of its work and becoming more and more a recognized part of it and an undisputed element in its growth. He has acquired the characteristics of the life about him—zeal, energy, alertness, readiness in meeting quickly changing conditions, and absorption in the work in hand. He plans rapidly, and executes to-day with an eye for to-morrow's profits.

With an engineering practice based solely on immediate results by way of expected profits in dollars and cents the esthetic element has little to do, though even here its absence may mean financial loss. But from the standpoint of this paper, engineering is to be considered in the broader light of Telford's well-known definition, "The art of directing the great sources of power in nature for the use and convenience of man," while the engineer is he who designs and executes engineering works. With an engineering practice based on a generous interpretation of the above, the artistic has much to do.

The engineer is primarily a designer. He works with the materials of Nature as his medium and her powers as his tools wherewith to express his thought and his purpose to serve and benefit man. Just as in the making of a picture the brushes, paint, and canvas are not the chief things, so here it is not the wood, steel and brass, or the powers of gravity, steam, air, and electricity, that are most important, but rather the character and quality of the design and the degree of realization in its execution. The design may be bad or good, according as it ignores or harmonizes with principles underlying all such acts of creation. The result may be a happy one only when the means employed are rightly chosen and properly adapted to the end sought. In this process of creat-

*An address delivered by Frank O. Marvin before Section D of the American Association for the Advancement of Science, at the meeting at Buffalo, N. Y., in August, 1896.

ing something of value, something that helps man to a fuller, richer and better life, the artistic cannot be left out. In its absence the design falls far short of its possible perfection, and man is deprived of what is due him, though not perhaps distinctly conscious of the loss. In a certain sense, then, every engineer is an artist, and in some directions at least, as in architecture and other forms of construction and in the making of public parks, the result of his cultured brain may attain to the dignity of a work of "fine art."

To the superficial or hasty thinker there may appear a conflict here between the utilitarian and the artistic, but there can be no real antagonism. The result of any act of designing is to be judged as a whole and in the light of all the purposes to be fulfilled. The physical conditions imposed by the materials used and the forces of nature employed are to be met. These conditions must be expressed in the design frankly and candidly, and in such a way as to indicate clearly its purpose, and to gratify the observer through its proportions, symmetry, harmony and decoration. The end desired must be attained in the most direct and simple way, so that the expenditure of money may be a minimum. These are the three elements of design. The scientific, the esthetic and the financial. A disregard of the first may mean structural or organic weakness on the one hand, or, on the other, an excess of material that unduly adds to the cost and at the same time may produce heaviness or ugly proportions in the completed work. Non-compliance with the demands of the second makes the design fail in fulfilling its complete mission, and this applies with the same force to those cases where a poorly directed attempt has been made to be artistic in expression, as to those in which no attention whatever has been paid to the matter. Artistic treatment often costs money, yet the mere expenditure of cash will not secure it. On the other hand, the proper display of good taste may often come without the spending of a dollar more than is made necessary by the other conditions surrounding the problem.

The current engineering practice gives great attention to the first and last of these elements, and but little comparatively to the second. There is no branch of it but would be benefited by adding to scientific and business ability a knowledge of the principles of artistic design, and an impulse to give an expression to it. The effect on the life of our communities and the nation by such a change is not easily estimated.

Some recent installations of power plants illustrate a movement that will have considerable influence on engine design. In many of our larger cities there are engine-rooms fitted up in elegance, with marble floors and wainscot, decorated walls and ceilings, brilliantly lighted and with all the appliances of the plant, engines, dynamos, switchboards, and even the smaller accessories in keeping with the surroundings. These plants are used as drawing cards or advertisements. There are other plants, not so used, where there is displayed less elegance, but fully as much artistic sense in adapting the room and its treatment to its purposes. In many of these places only the enclosed type of engine can be employed. In all of them the standard of maintenance must have its influence on the matter of design, which will in turn react on the former. An engine might pound itself to death in a dark basement, but would have its slightest vagary looked after in one of these better planned housings. This result cannot be entirely accounted for by the larger room, the better light, the rules and regulations. There is a refining, educating influence in these artistically planned constructions that makes better men and more efficient workmen of the attendants. Whatever they may cost, there is a credit side to the balance sheet.

Our railways are contributing toward this change. They have found the decoration of passenger trains a profitable thing, and, so stimulated, have carried it to excess. More significant still is the tendency to adopt high standard of maintenance, under which the roadbed is kept trim and neat, flanked by sodded slopes, and bordered by clean and well-kept buildings, and which also requires the rolling stock, the shops, and the yards to be maintained in a high state of efficiency. This is not necessarily in itself artistic, but it furnishes at least a necessary foundation. That the railway management understands to some degree the commercial value of the artistic element in its business is further evidenced by the nature of its advertising, that seizes on any advantage of scenery or artificial effect that is at hand.

Not much can be said in praise of the artistic qualities of our bridges, for these attributes are conspicuous through their absence. The American bridge satisfies the conditions of stability and least cost, but of beauty of line or balanced proportion that makes it fit into and harmonize with the landscape, or even that makes it considered by itself attractive, it has little. And this is to be the more regretted, because an intelligent application of right principles would improve the effect, without adding much, if any, to the cost, or making the structure less safe and durable. It is true that the truss with parallel chords, especially of the through type, does not lend itself readily to artistic treatment, yet even here something can be done. It is not so much of adding ornament as the proper treatment of the organic lines, the length of spans, the relation of length of panel to height of truss, the location of the piers, and the form of their outlines. Ornamentation is not to be used so much for its own sake, but rather where it is needed to accentuate these organic markings. There are some truss bridges of such size that they give pleasure to the observer through their massiveness, though lacking in other desirable qualities. The cantilever, like the Pratt and its relatives, is difficult of treatment, while arch forms, either braced or of the suspension type, are naturally pleasing and best adapted for artistic expression. Of these types we have a few satisfactory examples, like the Eads and the Grand Avenue Bridges at St. Louis, and the Brooklyn and Washington Bridges at New York. In our public parks are to be found many small bridges of good design, while in our cities there are some creditable ones of larger dimensions. There is some tendency toward the use of curved chords in bridges designed for urban use, and a further evidence of interest in the curved line through the introduction of the Melan arch. In some respects it is unfortunate that the economical element has driven out the stone arch, which possesses so many of the features of a beautiful structure for most situations, and it may be that this new form will become a substitute for the old, with added characteristics of its own. However much we may admire the inventive genius and mechanical ingenuity of those who have worked out the types of rolling or lift bridges that cross the Chicago River, the less said about the beauty of the designs the better. Perhaps the environment imposes ugliness on the designer. But that problem is hardly solved yet, and will not be until some man gets hold of it that combines aesthetic with scientific qualities, and has insight keen enough to see the possibilities of the situation and adroitness enough to manage, not only the physical, but also the human elements.

In the entire field of engineering there is no portion of it that includes a greater variety of intricate and difficult problems for solution than that connected with municipalities. Here the engineer has to do with matters touching the home life, the business life and the larger life of the city as a whole.

The engineer here comes in close contact with the people that daily and hourly use the results of his work. He already influences their health and bank accounts for the better, gives them greater ease and convenience at work or play, and saves their time. This is what is asked of him, and he meets the demand well. But what an uplift would come to city life, how much richer it would be, if he could put an artistic quality into his designing, and the people would learn to appreciate it! It is not to be inferred that there is an entire absence of this, but rather that artistic effects have been largely confined to individual cases, and not made manifest in the general life of the city.

For instance, there are numerous examples of suburban dwellings, beautiful internally and externally, and with harmonious settings; there are occasional business blocks whose treatment is satisfactory, but very few public buildings that have an adequate artistic meaning and are so situated as to express this advantageously if they did possess it. Without detracting in the least from the acknowledged merits of the design of Trinity Church, Boston, it must be admitted that its roomy location on one side of an open plaza adds greatly to its effectiveness. Think of its being placed in the middle of a block on Washington Street, or set in the midst of brown stone fronts on Fifth Avenue! All public buildings need both room and appropriate setting. They are the larger and more important pictures in the gallery of city structures; yet under the prevailing system of rectangular blocks, bounded by long, straight, and narrow streets, the hanging committee has nothing but the walls of corridors on which to place them. The worst of the matter is that the exhibition is a permanent one. Along these alleyways must also be hung the narrow, vertically elongated panels that seem to be so popular to-day, in favor because they pay. The observer needs a twenty-story ladder in order to study their details, or even to know if they have any, and can find no point from which they may be seen as entireties. At their sides hang strings of pictures whose horizontality exaggerates their skyward tendency. It is not the modern tall building in itself that is here objected to, but its location on sites that will not admit of a display of its best qualities. With wide, clear spaces about them and effective grouping they may be made agreeable, as is illustrated by the happy combination at the southeast corner of Central Park.

One of the good results of the tall building craze is the bringing closer together of two branches of designers; from the architect the engineer will learn more of art, and he will teach the former better construction. While retaining their separate functions, the collaboration will result in a higher mutual respect and appreciation, and a better grade of work on the part of each.

The rectangular plans of American cities are neither adapted to meet aesthetic conditions nor the demands of traffic. The long streets, without variation in width and direction, and without the breaks afforded by little parks, are tiresome to the eye. They are not placed with any regard for the topography or the natural features of the landscape, or to give prominence to some important structure, nor do they furnish directs lines of travel. But the plan is weighted down to the ground by millions of money. So it is not a question of what it ought to be, but one of mitigating the present evils and avoiding any repetition of these in the future.

Radical treatment must be resorted to by way of diagonal avenues from congested centers, and the widening out of the intersections of important streets into parks and plazas. There must likewise be an heroic struggle with the water fronts and internal water-courses, places full of picturesque possibilities, though usually given over to filth and ugliness. These changes are made imperative not only by esthetic requirements, but also by the demands of health and business.

In the planning of additions to large cities, the designer is hampered by the supposed necessity of tying to the older plan, by the desire of owners and speculators to realize to the largest extent on the sale of lots, or by his uncertainty as to what the future growth and character of the population may be. An examination of the block plan of many of our cities would show a heterogeneous arrangements of streets, especially in outlying districts, without regard to mutual relations, matters of grade and drainage, or artistic position. This irregularity may be more inconvenient and less pleasing than a right-angled plan. Our towns and smaller cities reproduce in miniature the conditions of the larger centers. Here, again, it is a question of improvement, instead of original design, only the problems involved are not so intricate and their solution not so costly. So it is hardly possible for a designer to plan an ideal city, or to have the full swing and liberty of the men who laid out the city of Washington and established its system of grades and drainage. But in spite of difficulties there exist some suburban districts laid out, built up, and adorned on the principles of good taste. Thanks to the systems of rapid transit that are increasing the number of these attractive places!

In the design and maintenance of water supply plants, American practice shows some respect for the artistic element. This is not confined to any particular system or any part of any one plant, but is quite general. The engine houses are not ugly and their interiors are often attractive. Gate-houses, aqueducts, and dams are decoratively treated, and form pleasing features in the landscape. The slopes of reservoirs are kept trim, and the grounds generally turned into lawns with flower beds, and perhaps a fountain. No doubt the sanitary conditions imposed have had much to do with this, but the result is none the less in good taste. We cannot avoid, however, a stray shot at the ugly stand-pipe, with conical cap, sometimes seen in our smaller towns. This is unnecessary. When enclosed it has been made an interesting object, and even the bare pipe can be ornamented in such a way as to relieve its nakedness.

There is much encouragement in the growing appreciation and enjoyment of public parks and boulevards. Cities and towns all over the land are trying to beautify what they already have, and are adding new territory to their park resources. Admirable skill has been shown in utilizing the natural features of the local landscape, the rocks, tree masses, meadows, ravines, ponds and streams, the wide expanse of ocean or glimpses of bright water. The curving roads and paths, with undulating gradients, have a beauty of their own, and lead one from point to point of the ever-changing scene, and yet bind it all into one harmonious whole. While the landscape engineer deserves credit, not so much praise can be given park commissioners for the artificial adornments which they have added to his work. Notwithstanding the fact that these are sometimes labelled as artistic, they do not always fit in appropriately.

The writer firmly believes that there is a latent aesthetic quality in American life that is now struggling to find means for its gratification and methods of expression. Before there can be knowledge of its meaning and power there must be many attempts and many failures. The whole process is one of education, and that largely in the school of experience. This applies to the industrial and constructive arts, as well as to the fine arts. The engineer will share in the general movement, but this is not enough. As a designer of so much that the world needs for daily use he must do more than keep up, he must keep in advance. He must not only have a capacity to enjoy, but also the power to originate and apply. To this end he must give preliminary study and thought to the principles of aesthetic design, so gaining an intellectual knowledge of them. American engineering schools are doing little or nothing to help the young engineer to this. So far as the writer knows, there is but one American textbook, Professor Johnson's book on bridges, that includes any discussion of the matter. A course of study in engineering esthetics near the close of college life would be a great help.

THE MOVING OF A FRAME BUILDING for a distance of 128 ft. was accomplished at Locust Point, Baltimore, Md., on Sept. 1. The building was a two-story frame warehouse of the Baltimore & Ohio R. R., containing a stock of crockery and glassware, and said to weigh 1,500 tons. The work was done by the aid of 1,000 iron pipe rollers and 90 screw jacks.

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The steam turbine is a promising machine which has as yet been but little applied to practical work, and there is therefore special interest attached to the results of the first important test that has been made in this country of a large de Laval steam turbine, which will be found in another column of this issue. The result obtained, 19,275 lbs. of water per electrical horse power hour, equivalent to 17,348 lbs. per brake horse power hour, is so low as to command respectful attention from all those who are considering the installation of new engines for furnishing electric power. The record of steam consumption at variable loads is quite remarkable, only 20.22 lbs. of water per electrical horse-power hour being used at 56 per cent. of full load. Not only in steam consumption does the steam turbine threaten the position of all but the highest type of reciprocating steam engines, but in the simplicity of its mechanism, the smallness of space occupied, and the little attention it requires while running. When a total equipment delivering 266 HP., including the steam turbine, gearing and two dynamos, requires a space of only 13 ft. 3 ins. × 6 ft. 5 ins × 4 ft. 3 ins., the saving of space, as compared with ordinary engines, is a most important matter in cities where space is expensive.

Without attempting to enter into the theoretical and political situation, some extracts from the 1895 annual on "The Mineral Industry," of the United States would seem to be pertinent, simply as information. Our readers can draw their own deductions. According to this carefully compiled volume of statistics, the value of the total mineral production of the United States, for 1895, was $678,000,734, including in the list 74 separate items. On the basis of a standard of market value at the place of production, coal holds relatively the first place with 31.8 per cent., or nearly one-third of the total value, and pig-iron comes next with 16 per cent.; the two together making nearly one-half of the whole value. There is a very wide gap between the value of these products and the third, which is gold, with 6.9 per cent. But the value of the silver product only amounts to 4.5 per cent. of the total, and is exceeded in value by the production of building stone throughout the country, and it is very little greater than the value of the lime burned last year.

A lately published open letter to Congressman Wilson, in connection with his bill "to organize and increase the efficiency of the personnel of the navy," makes one of the best presentations of the case of the engineer corps, and of the necessity for some speedy and radical measure of relief that has yet been made public. Congress is out of session just now, and things political are much mixed; but as the subject is to be vigorously pushed in the next Congress, and as educational methods are much in vogue at the present time throughout the country, we cannot refrain from some comments on this letter. The writer is Mr. Asa M. Mattice, late of the Engineer Corps, U. S. N., now a consulting engineer with Mr. E. D. Leavitt, and at one time an assistant to Commodore Geo. W. Melville, Chief of the Bureau of Steam Engineering, and highly commended by that department chief as an officer of exceptional qualifications and merit. While the letter of this ex-officer is exceedingly sharp and directly charges all of the existing trouble and contention to the actions of certain line officers who aim to control all legislation relating to the personnel of the navy, the actual conditions stated by Mr. Mattice tell a story of their own that ought to have a marked effect upon those to whom alone the engineers can look for relief. The Naval Register for 1896 gives a list of 714 line officers to 173 engineers; a ratio of 4.13 line officers to each engineer. In 1864, under war conditions, there were 2,846 regular and volunteer officers of the line to 1,728 engineers of the same branches of the service, or a ratio of 1.64 to 1; and in 1866, the regular line officers numbered 395 to 379 regular engineers, or practically equal number in both corps. The significance of this contrast between past and present conditions will be better understood when it is realized that the most powerful steam warship of 1864, the "Minnesota," had engines of 1,000-HP., while the protected cruiser "Columbia," of our new navy, has 18,500 I. HP., 90 engines and 172 steam cylinders, with the mass of varied and complicated machinery this power equipment would imply. Yet the "Minnesota" had nine engineer officers in 1864, and the "Columbia" has only four officers responsible for its vastly more powerful and important engines.

The original line officer was a sailor, and upon his training, skill and general knowledge depended the efficiency of his ship as a war-machine and its safety at all times, either on a lee-shore or in the face of an enemy. He was directly responsible for the motive power of the vessel and the handling of men and sails. To-day the line officer may direct the movements of his ship as before; but it is steam engines and not sails that do the work; and it is the engineer and not the line officer who is really responsible for the conditions of the machinery upon which the whole efficiency of the ship now depends. We fight as well as move by steam; and in the last thirty years the whole warship has practically been converted into one vast engine-room with an intricate maze of machinery that may make the difference between victory and defeat by failure in any one part of it.

How in the face of this radical and most important change in fighting and maneuvring conditions any loyal servant of the government can advocate an increase in the number of line officers at the expense of a corresponding decrease in the engineering staff is one of those problems that no man outside of the U. S. Navy can find out. With triple and quadruple engines, twin and triple screws, power for handling battery and ammunition, electric lighting and the multitude of mechanical devices found upon a modern battleship or cruiser, it is engineers we want and must have; and it may happen that the near future of naval warfare will demand that all naval officers be engineers before anything else. But at present each corps has its special and important duties to perform and the engineering staff very properly does not ask for command outside of its own distinct engineering department. This it should have along with the official status that the grave importance of its duties demands. The "warrant officer" scheme proposed by interested line officers is the veriest nonsense, that reflects little credit upon their good sense and would, in an emergency, very possibly react upon themselves and the government in causing the loss of a valuable ship. The demand in the engine-room, even more than upon deck, is for brave, highly educated, skillfully trained officers, with a rank that will ensure respect and obedience from every subordinate; and this can never be secured under any warrant system. Upon the engineer depends the efficiency and safety of government property, amounting to millions of dollars in value, the lives of officers and men and the honor of a nation; and to attempt to reduce this officer to the grade of a gunner or ship's carpenter is to put a premium upon disaster, even though there should be "one engineer" in a divided engineering command on each ship. If, as Mr. Mattice charges, the opposition to much needed reform in the personnel of the whole navy comes from a few bigoted line officers who have assumed control of naval affairs, the sooner Congress sits down very hard upon this fossilized clique the better for the credit and condition of our rapidly growing navy. Time will doubtless compel the reform; but the government cannot afford to await a contingency that may couple with it national disaster, and possibly discredit. Congress has the power to abolish this ring, if it does exist; and the apathy of Congress must be held responsible for any loss that may be sustained as a result of a continuation of not only an unjust but a very unwise treatment of a most worthy and necessary corps of government officers.

THE ARTISTIC ELEMENT IN ENGINEERING.

It is gratifying to note that the artistic possibilities of some branches of engineering are receiving much more attention of late than ever before, although still sorely neglected in most quarters. Some of the attempts to combine the artistic with the utilitarian have been abortive, as might have been expected from persons not possessed of even an elementary knowledge of the principles of art, while others are so creditable as to show conclusively that art and engineering are not incongruous, and to promise even better things for the future.

To those interested in the artistic side of engineering, and we trust all our readers are, we commend the abstract, published in another column, of a paper on "The Artistic Element in Engineering," by Mr. Frank O. Marvin, read before the Association for the Advancement of Science.

The author treats his subject in an interesting and sensible manner, indicating clearly why the matter should be given serious consideration from both the esthetic and financial point of view, and citing many phases of engineering into which the art element should enter.

The points so well made in the paper raise the extremely practical question, How is this artistic element to be introduced? For obviously it is still chiefly conspicuous by its absence in most American engineering works. Evidently the man who has been designing engineering works without a thought as to their artistic features until to-day cannot resolve to-night to introduce the artistic element hereafter and put his resolve into execution to-morrow. Much time and patient study will be required before the principles of art can be grasped by the novice and embodied in his work, but let us hope that in reality there are few engineers so devoid of art knowledge that some improvement in their work may not be expected from the moment their attention is directed to this end and thought and effort given to it.

The engineer has his limitations in this matter. He is not called on to take up the work of either the architect or the landscape engineer, any more that these two are expected to trespass on the domain of the sculptor, or the architect proper on that of the painter. But just as the work of the architect overlaps that of both the sculptor and painter, so does the work of the engineer overlap that of the architect and landscape engineer at some points. This makes it necessary for all to work in harmony, each realizing his own limitations and the possibilities of the other, and not hesitating to call for help when better results can be obtained by co-operation than by individual effort. Such co-operation already exists to a gratifying extent, but there might with advantage be much more of it and it should oftener be-

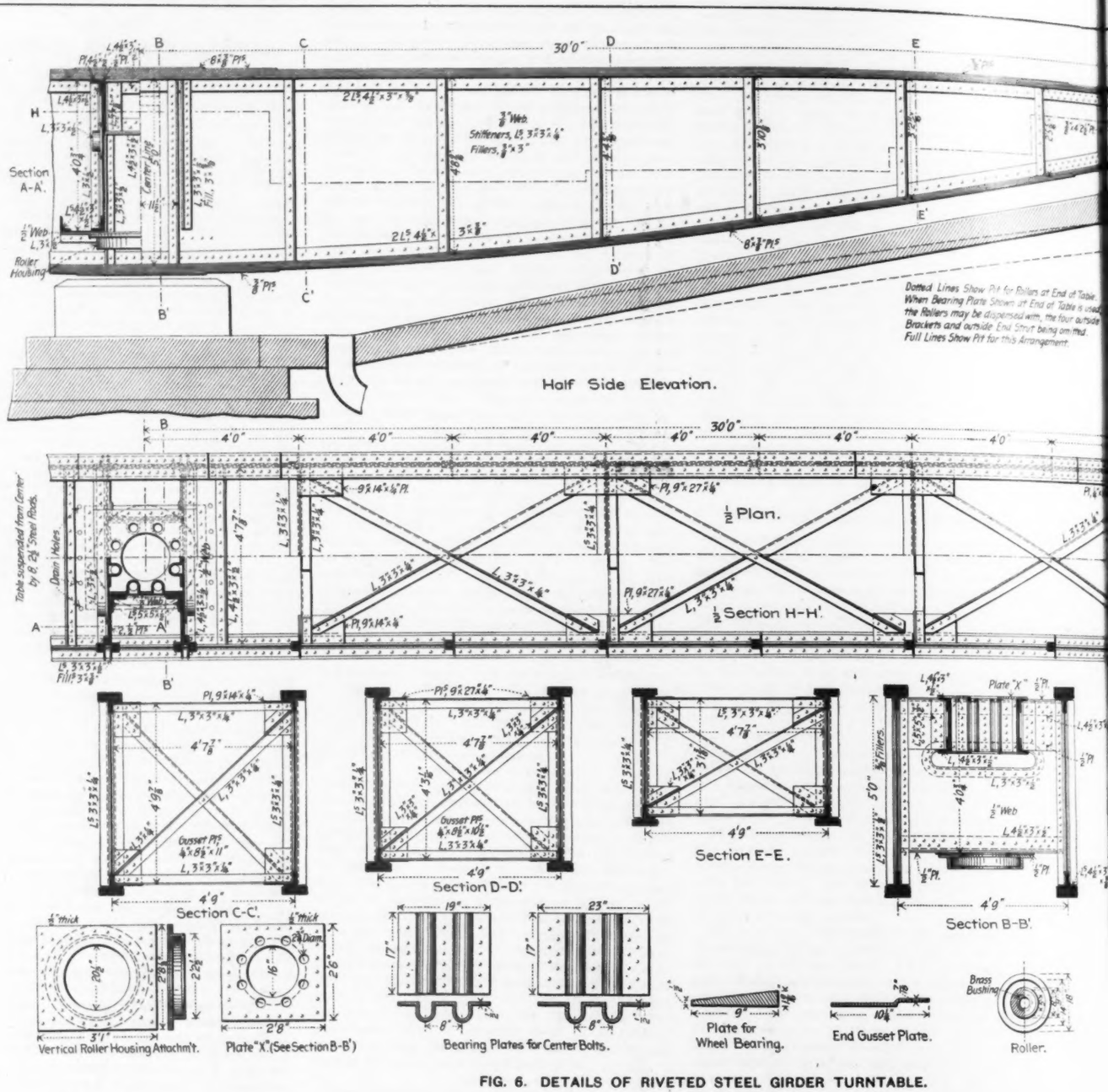


FIG. 6. DETAILS OF RIVETED STEEL GIRDER TURNTABLE.

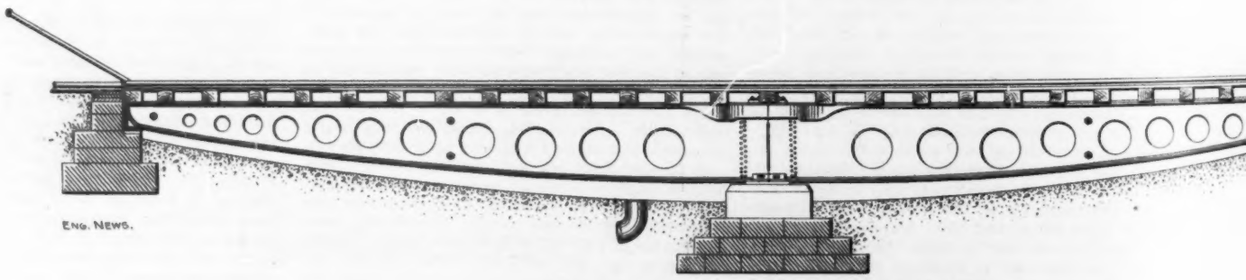
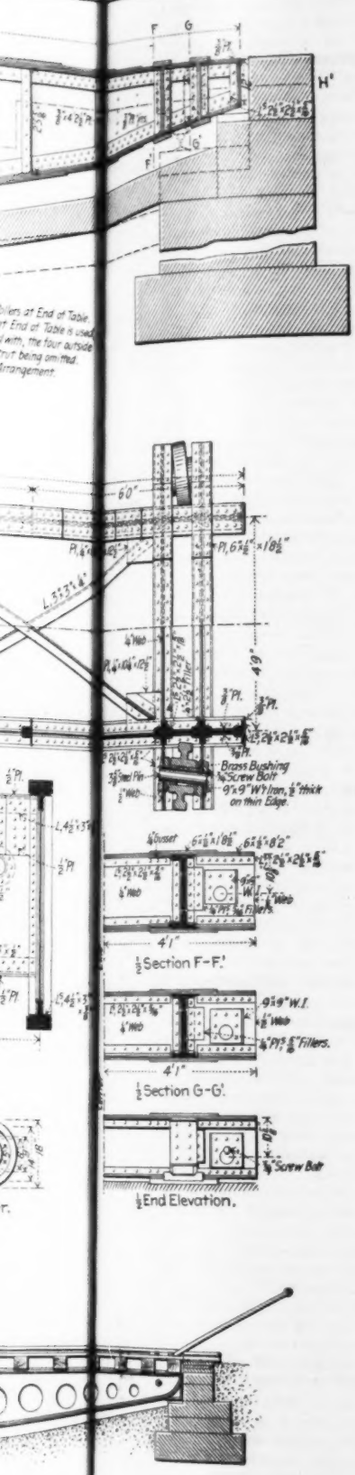


FIG. 2. ELEVATION OF CAST IRON TURNTABLE.

GREENLEAF CENTE

Greenleaf Turntable Co., Greencastle, Ind., Builders.



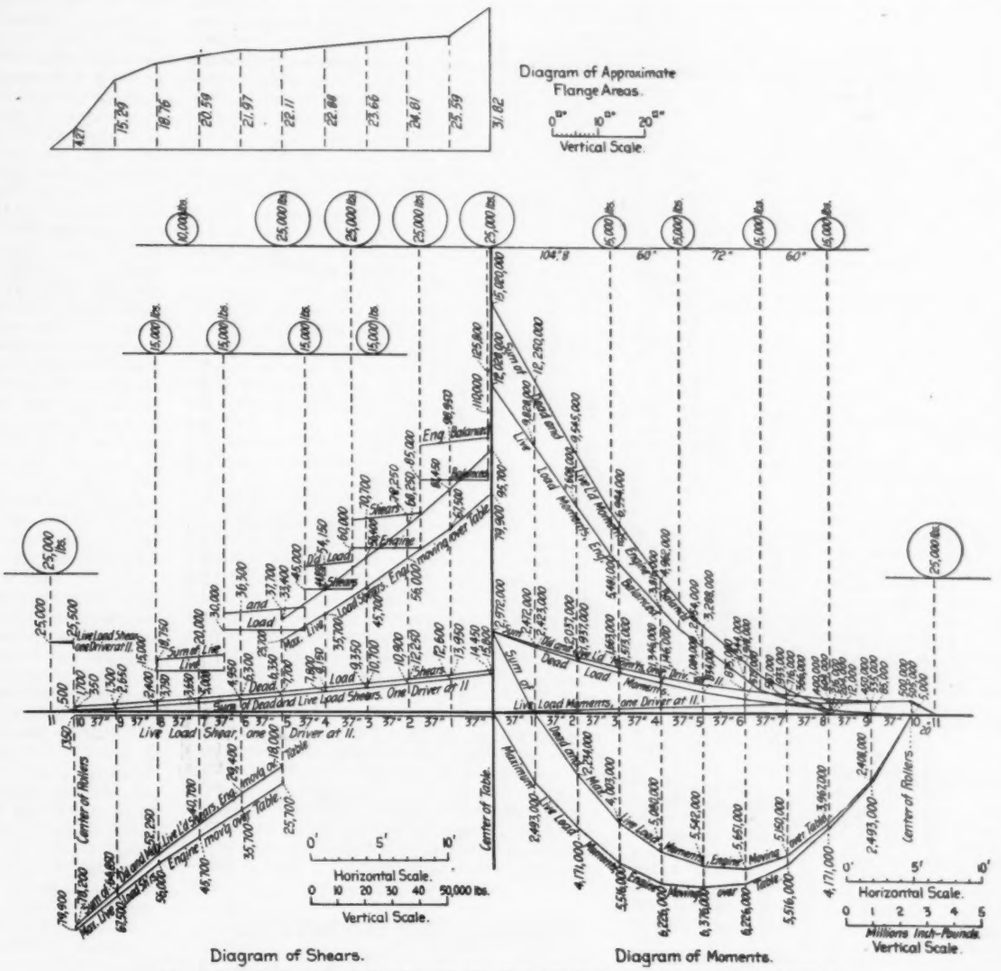


FIG. 1. STRAIN DIAGRAM FOR 65-FT. TURNTABLE OF 170 TONS CAPACITY

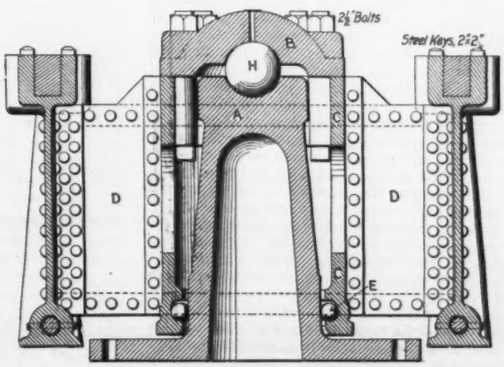


FIG. 3. TRANSVERSE SECTION CENTER BEARING.

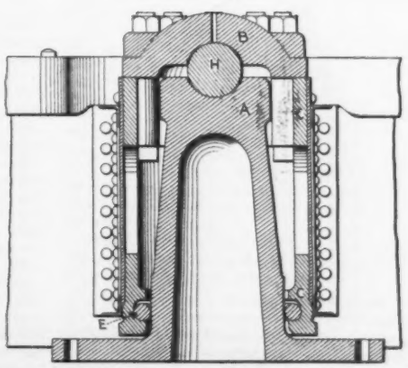


FIG. 4. LONGITUDINAL SECTION CENTER BEARING.

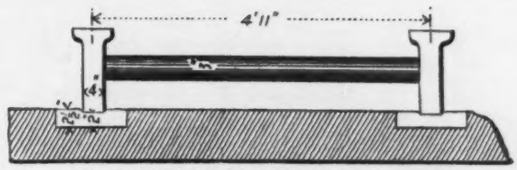


FIG. 5. DETAILS OF END LOCKING DEVICE.

CENTER BEARING TURNTABLE.

A. W. Greenleaf, M.E., Designing Engineer.

gin early in the design of the work in hand, instead of waiting until some of its features are fixed which might have just as safely and cheaply been so modified as to lend themselves more kindly to artistic treatment.

But however fully the engineer may work in harmony with the architect, he must himself have some artistic feeling and be able to express it in the broad outlines and even in some of the minute details of his designs, for it will not always be practicable for him to call on an architect, and he should in any event have a sufficient understanding of art to make possible a bond of sympathy between them. The engineer will find it to his credit if he is able to so group and proportion his materials as to get the best effects in grand massiveness and stability, or airy lightness without a suggestion of frailness and perishability. He must realize that ugly details mar structures, no matter how pleasing their general outlines and proportions may be, and he must know what ugly details are, so that in case he is not able to design anything else he may call upon some one who is. He must have an innate sense of the fitness of things, placing ornament only where it belongs, and always using it in a proper degree of richness, such as the character of the work in hand and the material and money at his command will warrant. His means will oftener than not be limited, especially for ornamental purposes, so he must know the artistic capabilities of his materials and be able to make much out of little.

No five words can be more helpful to either engineer or architect than the maxim, "ornament construction, never construct ornamentation." This means simply to make each useful and essential part of a structure as artistic as may be consistent with its object and to stop there in attempts at ornamentation, instead of "sticking on" ornament. For example, a bridge railing would as fully prevent passers from falling into a river or ravine if it consisted of only a flat piece of iron supported by plain iron bars at considerable intervals, but something more pretentious, if not always more artistic, is attempted, and in this one simple detail the engineer too often fails by selecting a design that would look well enough if used to fence in a front yard and was well veiled by shrubbery, but is utterly unsuited to its actual massive and simple surroundings. As an example of what to avoid, there might be mentioned one costly bridge in the city of Philadelphia which is so disguised by galvanized iron applied to the panels that it presents a long arcade of masonry arches of short span supported upon space. The details are carefully carried out in this case, but the original conception is wrong and the general effect is very unpleasing—simply because it tells a structural lie in attempting to conceal the true lines of stress.

If what has preceded is true, it may well be asked, how is such artistic perception and skill as may be necessary or desirable to be obtained by the engineer? As already urged, it is not a mere matter of resolution, although that is the first step. Engineers already in practice will find ways of improving themselves, if once they set about it, making use of the same general methods they would pursue to acquire knowledge in some other lines. They will naturally have recourse to books on art, to lectures on the subject, when possible, and, above all, to a close study of such examples of art in engineering as are available for the purpose. But with the many pressing demands which an engineer in good practice has to meet, any great progress is not to be expected for some years, at least, beyond an appreciation of the artistic element and a realization that, except in minor matters, he must call upon some one with more artistic training and ability than he possesses.

With those looking forward to engineering as a profession the case is quite different. They may pursue the study of art to such an extent as they see fit, provided the advantages of such a course are impressed upon them, and facilities for it are available without such great trouble or expense as to make it impracticable for the majority of engineering students. As a matter of fact, such students are really dependent on their instructors for guidance in this matter, and in many, if not most, cases for even an intimation that such knowledge is desirable, to say nothing of being necessary, for the highest degree of success in most branches of engineering.

There is practically no opportunity for such training in our engineering schools, so that the student must seek it elsewhere or go without it. We will not venture to suggest how the matter should be approached by the engineering schools, nor even to say that they should attempt to provide such training. But we do not hesitate to urge that if art in engineering is to become general the engineer should have some instruction in it, and that this could be obtained most naturally and certainly during his schooldays.

Our engineering courses are already overcrowded with subjects which pertain to the general education and development of the man, rather than the fitting of the man for his chosen calling. In some of these schools the youth is taught, and imperfectly at that, to write English, is given a little history, a smattering of botany, and takes up many other studies which he might very properly have completed before beginning his engineering course.

If these general subjects were studied before entering the engineering school, or, in other words, if the engineering course always followed general collegiate studies, the principles of art might be acquired at the same time, and their practical applications to engineering pointed out in the engineering school. As it is, an attempt is being made to give young men, and in many cases mere boys, a course in engineering and a part of a general college course at the same time, to the greater or less detriment of both courses. We are well aware that there are many reasons for this practice, some of them most excellent, and that otherwise hundreds of engineers to-day would have had no part of a general college training.

But we still contend that for the broad success at which all students aim some fundamental artistic training is essential to all, whether the later chosen profession in life is engineering or any other branch of science or the arts. It is a part of the early mental equipment that is too often neglected, though it is, or should be, a potent factor in both our practical as well as esthetical life.

LETTERS TO THE EDITOR.

Proposed Standard Specifications for Portland Cement.

Sir: In your issue of July 16 appears an interesting review of the standard specifications for Portland cement, proposed by Mr. Wm. J. Donaldson. The need of such a system of standard requirements is certainly very great, as must be apparent to any one who has had occasion to study the extremely variable specifications drawn up from time to time by government engineers. Such a set of official requirements would also serve as a standard for private practice, and would be of inestimable value and convenience to engineers and cement consumers. Mr. Donaldson certainly deserves great credit for having taken the initiative in this important matter, and it is greatly to be hoped that the subject will be taken up by government and private engineers, and an agreement arrived at. It would help the matter along most decidedly if the American Society of Civil Engineers would attack this question anew, and establish a series of cement tests in keeping with modern practice in other countries. The recommendations of the Committee of the Society (1885), are very general and indefinite, and fail to supply the clear and exact rules necessary for uniform work and reliable results. Most other nations have distinct official requirements, which agree, in general, with each other in important matters. Those of Germany undoubtedly represent more careful study and experiment than those of any other country. For many years committees of the Association of German Cement Manufacturers have worked in connection with the officers of the Royal Experiment Station to perfect these official requirements and they consequently embody the latest information which is to be had on the subject.

The writer supposes Mr. Donaldson's recommendations in regard to detailed requirements to be intended chiefly as suggestions, and is not therefore disposed to criticise closely the specifications or methods of tests proposed. A few defects in the specifications given may, however, be briefly pointed out.

Quality.—The requirement that cement should be exposed to air for 30 days before shipment is a new one, and in the opinion of the writer, unnecessary. Well-made cement should be perfectly sound when fresh from the mills. Bad cement may often require several months of seasoning before it is fit for use. The question of soundness can be tested in other ways, and a certain length of time of seasoning is no guarantee of good quality.

Chemical Composition.—A requirement that the cement shall contain lime, silica and alumina within certain limited percentages, seems to the writer to be superfluous and misleading. The limits, if established, must be very wide, and if so, are useless. For given materials the proportions must be nearly exact, but different materials yield cements of widely varying composition. The cause of this difference is chiefly the varying composition of the clays used, a silicious clay requiring far more lime than an aluminous one. Mr. Donaldson's requirement for silica (20 to 22%), is especially narrow, and would exclude Dyckerhoff and the cement Mr. Donaldson is himself interested in manufacturing, which, according to analyses made in the writer's laboratory, showed respectively 19.35 and 22.5% silica.

Fineness.—The proposed requirements of 95% through a No. 100 sieve, and 80% through a No. 200 sieve, are out of all reason, and would exclude more than nine-tenths of the best German and American cements. Within the past month the writer has tested samples of the cement in which Mr. Donaldson is himself interested, obtained from dealers in several of the larger cities, and none of these samples come anywhere near passing these requirements. There are few, if any, cements now on the market which show over 90% through a No. 100 sieve. What the fineness on No. 200 may be the writer cannot say, as he has never seen a correct No. 200 sieve, and doubts if one exists. Samples of best foreign wire cloth proved to be 184 × 187 mesh, and very uneven, when examined under the microscope. None of the leading brands of cement, German or American, showed over 70% through this sieve. The time will doubtless come when a higher degree of fineness will be demanded by the trade. The introduction of the tube-mill is making it possible to obtain such a degree of fineness as Mr. Donaldson describes. From tests of American and foreign cements now in the market, however, it does not appear that the tube-mill has found extensive use up to the present time. In the opinion of the writer, a requirement of 90% through a No. 100 sieve is amply sufficient. This requirement will exclude most English and many German cements, while the leading brands of American cement will pass it satisfactorily.

In all requirements for fineness, the gage or diameter of the wire, as well as the number of meshes, should be distinctly specified, as variation in this respect will make an immense difference in the results. The German official requirements specify that 90% shall pass a sieve of 76 meshes to the linear inch (900 per sq. cm.), in which the diameter of the wire is one-half the width of the opening.

Test for Checking and Cracking.—The writer finds that exposure of the pats to hot steam (after setting over night), instead of placing them in boiling water, gives more satisfactory results. Five hours in hot steam (200° F. or over) will be found sufficient to detect the slightest tendency to expand or crack.

Specific Gravity.—This test is of little value, since even unburned cements usually show a specific gravity of at least three, and the increase due to perfect burning is extremely slight.

Setting.—The temperature of the room and of the water used should be specified, as these exert an immense influence on the time of setting. The pats should also be kept in damp air in a closed metal box. The proportion of water used should also be such as to give a constant consistency, both for tests of setting and tensile strength. The German requirement is that the proportion of water shall be such that when a quantity of the paste is placed on a plate of glass, several taps on the slab will be necessary to cause it to spread to the edges. This may seem a rude method, but practical trial will show it to be simple and fairly definite.

Tensile Strength.—Much more uniform results are obtained by filling the molds, then turning them over and filling again from the other side.

A requirement of a certain strength at one day is very objectionable. Nearly all well-informed engineers have abandoned the practice of making one-day tests.

The mixture for briquettes should be worked a certain definite time. Three minutes is a good minimum. Sand briquettes must be pounded into the molds to give uniform results. The German requirements specify that this shall be done with a spatula of certain size and weight. The writer has obtained the best results by filling the mold above the top, then laying a small block of wood over it and pounding lightly with a mallet, repeating on the other side.

The amount of water for sand tests, as proposed by Mr. Donaldson, namely, one-half the amount used for neat tests, will be found rather high. The Germans use 10% of water for sand tests, 1 to 3, with all cements. Neat tests will generally require 22 to 25%.

The use of crushed quartz instead of sand seems to the writer very objectionable. The Germans use a normal sand, 20 to 30 mesh, from Freienwalde on the Oder River. This shows about 33% of voids, while American standard crushed quartz of the same fineness showed 50% of voids. The quartz is in the form of glossy splinters, while the sand is made up of roughened grains. For these reasons the

quartz gives much lower tests than a pure sand, and the results are less indication of the way the cement will work in practice. The crushed quartz is also very costly (about $10 per barrel), an important consideration where many tests are to be made. There is no reason why a good quartz sand, from some one locality, should not be adopted as a standard in this country.

In spite of the above criticisms, it should be said that Mr. Donaldson's suggestions are, on the whole, extremely good, and show careful study of the subject. It is earnestly to be hoped that they may lead the way to further discussion, and to the adoption of a definite standard of cement-testing in this country.

S. B. Newberry,
Manager Sandusky Portland Cement Co.

Sandusky, O., July 30, 1896.

Sir: In your issue of July 16, 1896, you give several columns of your valuable space to a "Proposed Standard Specification for Portland Cement," by Mr. W. J. Donaldson, of Philadelphia, the object of which is "to urge the adoption by the United States of a standard specification for Portland cement, the use of which should be required on all work done under the direction of the officers of the Corps of Engineers, and also by the Navy, the Supervising Architect's office, etc."

The formulation of such a specification seems to be a pretty large piece of work for one man to "go it alone" on, and its publication even, by so well considered a scientific journal as your own, may lead to serious results by its use without examination by those who have not perceived its errors and inaccuracies.

The matter of the making of specifications is a grave one. In Germany, committees of the Cement Manufacturers' Association, acting with government co-operation, have been sitting for three years awaiting the results of experiments before merely recommending changes in recognized standards; in France, the Commission des Methodes d'Essai des Materiaux de Construction was constituted in 1891, and did not report until 1893; in this country our American Society of Civil Engineers was several years considering its specifications for cement, and since their adoption in 1885 has made no changes. So that, broadly speaking, the scientific and engineering world, knowing how much the question of reputation of engineers, architects, contractors and even cement manufacturers is involved in any new specifications for cement, or even any change in the same, has ever been slow to recommend and ever slow to adopt new rules or changes in normal standards. Why, therefore, it should have remained for Mr. Donaldson to formulate of his own motion this radical departure from old landmarks, he best can explain; but to those of us engineers or associated with engineering societies here and abroad, it seems to partake of foolhardiness, unless by reason of long experience, great knowledge or deep scientific thought and authority, he can justify his action, or unless his cement has been rejected on present government specifications (Dist. of Columbia, 1895), and he proposes in the future to "make the punishment fit his crime" alone. The proper way, however, to consider such a matter, would seem not to jump off at a haphazard guess or opinion as to what sort of a specification would suit any one cement or class of cements, but to look carefully into the history of Portland cement, its methods of manufacture, its uses, its results on works and the accepted standard specifications of the world before laying down any arbitrary rules.

Now, the use of Portland cement in a large way dates back to the time when John Grant first began to adopt it on the London sewers, and his book, published in London by E. & F. N. Spon, in 1875, gives a summary of his papers read in December, 1865, and April, 1871, before the Institution of Civil Engineers in London. It was an outcome of the tests then described, and of the bold use of cement thus mentioned, that engineers began to have faith in Portland cement, up to that time an article of doubtful engineering utility. Following Grant, the French and German engineers began to employ large quantities of Portland cement, and in the latter part of 1880 it came to be largely used here in America for engineering work; though it was used prior to that for paving. Therefore, as engineering and architectural faith rests on Portland cement, so far as permanence and durability are concerned, on these uses abroad, it behooves him who would make specifications to consider first what were the methods of manufacture in use in England when Grant was working and what requirements he had for Portland cement and what results he obtained. It would be also his duty were he minded to be fair and candid to follow this up by an examination of the figures of Mr. Reginald E. Middleton, published in "The Engineer," Vol. 65, p. 279 (London), giving records of long-time tests on a number of various cements which gave varying results at seven days. It would next become necessary for him to examine the long-time tests of the New York Aqueduct, of the Niagara Tunnel and other large work in this country, and then he would be in a suitable frame of mind judicially to consider the question. To such an one, it would appear that all the Portland cement on which long-time tests by engineers or other unbiassed parties have been made and published, and thereby have become engineering authority, have been cements made in Europe or America by the same methods practically as the cements used by Grant. Clay and chalk, limestone and clay, marl and clay, argillaceous limestone and limestone, have according to their chemical constituents been ground together either wet or dry, and either with the water they contain or with water added, have been made into a mud (slurry) or bricks containing the requisite chemical ingredients of lime, silica and alumina in finely comminuted particles. In every case the result has been to make a new stone, brick or block with the finely subdivided grains of the several chemical ingredients; artificially rearranged and in close mechanical union for the action of the fire of the kiln. In every case these bricks or blocks have been burned in closed or continuous kilns where the material was brought into close contact with the flame of coke or coal, and the uniform distribution of fuels in layers through the mass has caused uniform burning and clinkering. In every case the resultant powder, caused by grinding the clinker, has been shipped to the consumer without the addition of sulphate of lime incorporated with it after grinding, to give it fictitious strength and most dangerous qualities. So much for the process of manufacture, and on this point it seems clear that if engineers and architects are to rely in their work on the experience of other engineers, they should know what process the cement they are offered is manufactured under, and if it varies from the established standards which have given the standard results, on which our knowledge of cements rests, then as a prime requirement of any specification "proposed" or otherwise, the mode of manufacture and the long-time tests of the cement offered should be considered and inquired into regardless of abnormal 7 and 28 day tests and other similar data.

In order to go over the "proposed" standard specification of Mr. Donaldson, I have taken considerable trouble to gather together the leading specifications of this country and Europe, for purposes of comparison and also for the purpose of emphasizing what the world of engineers and not one cement manufacturer alone thinks on this important subject. Some of these specifications formed part of my contribution to a discussion before the Engineers' Club, of Philadelphia, and others recently gathered show a marked swing in the pendulum in favor of the elimination of boiling tests and other uncertain methods, and also in favor of much lower tensile strains, neat at 7 and 28 days.

Taking up the Donaldson specification in detail no careful manufacturer would object to seasoning his cement as this is common practice but why a manufacturer should under Clause 2 furnish "certified tests from the laboratory on every car furnished, which shall in no wise be a guarantee of acceptance by the government, as acceptance or rejection will be made on government tests"—is beyond explanation and seems a work of supererogation. So far as the clauses relating to packing and sampling are concerned they are not new and therefore are unobjectionable.

The matter "of a chemical composition" is too serious a one to lay down arbitrary rules about which would exclude nearly all of the cements used in Europe and America by the best engineering talent for years past. Mr. Donaldson's figures are as follows:

Lime, 62 to 66%.
Silica, 20 to 22%.
Sesquioxide of iron and alumina, 8 to 12%.
Magnesia, not over 3½%.
Sulphuric acid, not over 2% for slow setting cement.
Sulphuric acid, not over ½ of 1 % for quick setting cement.

The proof of the absolute unreliability of such a chemical requirement, as that submitted, is best shown by reference to Candlot's "Ciments and Chaux Hydrauliques," Baudry & Co. Paris, 1891. On p. 76 this leading authority gives analyses of no less than 12 French, 13 English, 6 Belgian and 14 German Portland cements of commerce. Out of this total of 45, no less than 36 exceeded in silica, Mr. Donaldson's requirements; no less than 9 exceeded the requirements of alumina and iron; not a single one contains magnesia up to 3½% ;only 3 exceed 2% magnesia, and only 1 contains sulphuric acid up to 2%. As to the important element of lime, no less than 20 contain less than 62% of lime, and only 6 contain over 64% of lime.

Another eminent French authority, Professor Le Chatelier of the Ecole de Mines, Paris, in a paper read at Chicago, "Trans. Am. Inst. Mining Engineers, International Engineering Congress," August, 1893, p. 14, gives as composition of commercial cement of good quality, a material which would fall "outside the breastworks" of Mr. Donaldson's specifications, in the elements of lime, silica, magnesia and sulphuric acid. Still another, Feret, in his monograph on the addition of plaster (sulphate of lime), to Portland cement, "Librarie des Ponts et Chaussees," Paris, 1890, p. 67, shows conclusively that the presence of anything like 2% of sulphuric acid in cement to be used in salt water would invariably cause the disintegration of the mortar, and yet this point is entirely overlooked in these new specifications. Furthermore, so eminent an authority as Baron Quinette de Rochemont, Inspecteur General des Ponts et Chaussees, in his work on "Portland Cement at Havre," "Institution of Civil Engineers," London, Vol. CVII., 1891-92, p. 9, in describing the disintegration of certain cement, says the cement "now in its worst state" was "analyzed by the laboratory of the Ponts et Chaussees, and showed alumina and iron 9.80, and lime 62.95," or exactly within the lines proposed by Mr. Donaldson. The French government, in the marine service specifications, especially provides that Portland cement must not contain more than 1% of sulphuric acid. Cahier Guesain, Art. 6.

German authorities against such chemical requirements as Mr. Donaldson proposes, are equally weighty—Professor Tetmajer, of the Zurich Polytechnicum, a leading scientist, in his work on "Hydraulischen Bindemettel," Zurich, 1893, gives on pp. 146 et seq. analyses of 88 German, Austrian, French and Swiss Portland cements, made by 16 leading European chemists. This list of cement includes such well known brands as Stuttgarter, La Farge, Mannheimer, Heidelberger, Dyckerhoff, Vervohler, Shifferdecker and De Grand Champ.

Out of the entire 88 cements, no less than 57 fall outside of the limits of silica, a large number contain alumina and iron in excess of 12%, and, as to lime, no less than 59 contain less than 62% of lime, and only 6 contain lime up to 64%. Of magnesia, only 7 out of 88 contain 3½%. Of sulphuric acid only 13 run up to as high as 1½% when the sulphate of lime (Ca S O_4) Tetmajer gives is reduced to its elements.

To a similar purpose may be quoted Dr. Preussing's table of analyses read before the German Cement Manufacturers' Association at their 1894 meeting (Berlin, Funcke & Co., 1894), where out of 24 cements analyzed only 14 had lime in excess of 62%; only one magnesia in excess of 2.68%, and not a single one had sulphuric acid up to 2%.

The English are no less positive in their chemical determination. Redgrave, "Calcareous Cement," London, 1895, p. 145, quoting Margetts' paper before London Institution of Civil Engineers, 1891, shows that none of the cements there mentioned would have met Mr. Donaldson's proposed specification.

When W. F. Reid wrote on "Portland Cement," Philadelphia, H. C. Baird, 1869, on p. 12 of Lipowitz' paper there printed, he gives analyses of eight Portland cements, not one of which fall within the requirements referred to, and not one of which contain magnesia up to 2½%. In the work by Henry Reid, the eminent authority, London, 1879, p. 50, the "good Portland cement" he gives an analysis of, would likewise have failed if tested by Mr. Donaldson. Another writer and engineer, no less than the late Henry Faija, of London, in his last paper, Trans. Am. Soc. C. E., Oct., 1893, p. 43, knew nothing of these new specifications when he described the elements of Portland cement, entirely outside of the new lines just published. The eminent engineer, Carey, in his paper, "Inst. Civil Engineers," London, Vol. CVII., 1891-92, p. 35, was in a similar state of ignorance when he described as a "good Portland cement" one which would not pass Mr. Donaldson's specifications.

So, too, was Collins in a similar state of darkness when he made his definition of an average composition of a "sound Portland cement" in his book, E. & F. Spon, London, 1888, p. 8.

So much for European authorities, who by reason of their longer use of Portland cement, might be supposed to know something about its chemical constituents; but even the weight of American authority is against Mr. Donaldson. The analyses of Dyckerhoff, Brooks, Shoobridge, Alsen and Giant Portland cement by the late Prof. De Smedt, the well-known authority and for many years Inspector of Cements, U. S. government (Rep. Dist. of Columbia, 1885, p. 47), show that each and everyone of these well-established brands would have been rejected under these new views of chemical elements. Furthermore, not one of them shows sulphuric acid up to 1%, and only 1, magnesia approaching 3%.

As for Prof. Spaulding, of Cornell, in his work published Ithaca, 1893, he is likewise wrong on p. 4, when he describes the requirements of a Portland cement, and the same may be said of Prof. Jameson, who, in his "Monograph," Iowa City, 1895, p. 4, lays down chemical elements outside of Mr. Donaldson's narrow bounds. Finally, to prove our new authority right and the older cement authorities wrong we must also overrule that distinguished writer, Gen. Gillmore, "Cements and Lime Mortars," New York, 1879, p. 65, in his analysis of Portland cement there published.

On the other side, therefore, we have the concensus of the world's authorities, of France, Germany, England and America; on the other side we have Mr. Donaldson. What weight should his opinion carry? What is his chemical and scientific reputation? His first work on cement: "Alpha Portland Cement," Donaldson & Co., Philadelphia, Allen, Lane & Scott Press, 1894, p. 4, contains a description of manufacturing Portland cement, and one paragraph is as follows: "The company find the rotary cylinder process the least expensive of any they can use, it being especially adapted for their raw material, as it is not refractory; the carbonic acid is readily driven off and is then easily ground to a fine powder."

On the strength of a chemical knowledge enabling one to grind "driven off" "carbonic acid to a fine powder," in the process of making cement, Mr. Donaldson may seek to

overthrow the weight of the world's chemical opinion, but chemists will hardly permit it, and even he, himself, is doubtful about his own knowledge, for in his second book, the one now under criticism, the amount of magnesia is set down in print at 2½%, and then subsequently changed in ink to 3½%, and he likewise altered the time of setting by a communication to you of July 21, 1896, published July 23, 1896.

Is this, therefore, such a voice as we should listen to, an authority, which, without a single citation or fact, sets up a chemical standard contrary to that which scientists of world wide reputation have fixed, and by whose specifications anywhere from 80 to 90% of the cements of established reputation the world of engineering has been using from 30 to 40 years, would be excluded. On the face of his known chemical knowledge, as shown by his own writing, Mr. Donaldson is condemned.

As to fineness, Mr. Donaldson is again arrayed against the world's scientific opinion; though no careful manufacturer would hesitate to guarantee cement of the fineness he recommends, namely 95% on 10,000 mesh sieve and 80% on a 40,000 mesh sieve. From a careful examination of many specifications, in Europe and this country, the following seem to be the requirements for fineness.

Residue.

Belgium, 15% on a 5,800 mesh sieve (Genie Belge).
Germany, 10% on a 5,800 mesh sieve (Rules Prussian-German Society).
Switzerland, 15% on a 5,800 mesh sieve (Report Tetmajer, Zurich).
France, no fineness specification (Clahier des charges, Ponts et Chaussees), (or in Government Commission Report).
France, 5% on a 5,800 mesh sieve (recommended by Le Chatelier and Candlot, French Chemists).
Roumania, 12% on a 5,800 mesh sieve (government specifications).
England, 8% on a 2,500 mesh sieve (recommended by H. Faija, World's Fair Congress, August 2, 1893).
United States, recommendation American Society of Civil Engineers, June 27, 1893, says: "Cements of better grades are ground so fine that only from 5% to 10% is rejected on a sieve of 2,500 meshes per sq. in.

Under this recommendation are the following specifications in this country:
New York Aqueduct, 80% on a 10,000 mesh sieve.
City of Baltimore, 90% on a 3,000 mesh sieve.
Department of Public Works, New York, 90% on a 2,500 mesh sieve.
Pennsylvania R. R., 90% on a 2,500 mesh sieve.
U. S. government, Dist. of Columbia, 95% on a 2,500 mesh sieve.
U. S. government, District of Columbia, 85% on a 10,000 mesh sieve.
U. S. government, Supervising Architect, no fineness specified.
Niagara Falls tunnel, 80% on a 10,000 mesh sieve.
Reading Terminal, 95% on a 2,500 mesh sieve, 75% on 10,000 mesh sieve.
U. S. government, Board of Engineers, 95% on a 2,500 mesh sieve.
City of Philadelphia, 90% on a 10,000 mesh sieve.
City of Philadelphia, 70% on a 40,000 mesh sieve.
New York Central R. R., 97% on a 2,500 mesh sieve.

Under the head of Cracking and Checking volumes might be written on the subject of hot tests or boiling tests and no conclusion arrived at; no two sets of scientists, no two sets of engineers, no two sets of experts have yet been able to agree as to these tests, their utility and their practical methods of use. The last report of the committee of the German Association of Cement Manufacturers presented at the 1896 meeting on this subject asks until 1898 to report, and meanwhile the normal cold water tests remains unassailed. On the other hand, the French commission, above referred to, recommends a moderate boiling test for slow-setting cement only, and this only in a tentative way. On this point the consensus of opinion all over the world seems to be against Mr. Donaldson and his recommended violent boiling test. It may be summed up as follows:

Germany—After three years' discussion, the boiling test was finally reported against at the session of 1893, by the German Cement Association, operating in conjunction with the Prussian Minister (Gary's paper, World's Fair Congress, Aug., 1893; Trans. Am. Soc. C. E., Oct., 1893, p. 13), and subsequently a committee to further investigate was appointed.

French Government—Conference of engineers Ponts et Chaussees, Cahier Guillain, Service de la Marine, Service de Colonie. None of these contain boiling tests. The French commission report is above referred to.

England—Faija's paper, World's Fair Congress, Aug. 2, 1893, Trans. Am. Soc. C. E., Oct., 1893, p. 59, recommends steaming tests only, and immersion at 116°, and requires no boiling test, which he admits he has abandoned as unreliable, though first proposed by himself.

United States—U. S. government, District of Columbia, specification, 1896, abandons boiling test. F. H. Lewis (Booth, Garrett & Blair testing laboratory), Philadelphia Engineering Club, Vol. XI., 5, 1895, p. 345, abandons boiling as "unreliable in indicating quality of cement." Am. Soc. C. E. specification recommends cold water and air tests only.

Under the head of tensile strength, Mr. Donaldson again runs his head against the requirements of the leading authorities here and in Europe. He requires:

Neat briquettes shall stand a minimum strain per sq. in. 12 hours in air, 12 hours in water, 200 lbs; 1 day in air, 6 days in water, 500 lbs; 1 day in air, 27 days in water, 650 lbs.; and briquettes of of 3 sand and 1 cement: 1 day in air, 6 days in water, 150 lbs.; 1 day in air, 27 days in water, 250 lbs.

In order to show the absolute inaccuracy of such specifications, I have gathered in Europe and this country the principal specifications for purposes of comparison, and there will be found below, a summary of requirements and tests under the branch of testing. In the case of European specifications, kilogrammes and centimeters have been roughly reduced to pounds and inches.

	Neat Tests. 7 days. lbs.	28 days. lbs.
France	284	497 (Cahier Guillain)
Russia	255	(Russian public works.)
Belgium	255	497 (Genie Belge.)
England	350	550 (Faija) (Carey.)
Germany	No neat requirements.	
American Society of C. E. (250 to 550 lbs. at 7 days, 350 to 700 lbs. at 28 days tests recommended).		

Under these recommendations are the following American specifications:

	7 days. lbs.	28 days. lbs.
U. S. Govt., Lighthouse Engineers, 1893	400	...
U. S. Govt., Army Engineers, 1893	450	...
U. S. Govt., Supervising Architect	300	...
U. S. Govt., District of Columbia, 1895	400	500
City of Philadelphia	450	550
City of New York	300	...
City of Baltimore	400	...
New Croton Aqueduct	300	400
Niagara Falls tunnel	300	400
Pennsylvania R. R. Co.	303	412
New York Central R. R.	300	500
Reading Terminal	350	...
Baltimore & Ohio	300	...
Lehigh Valley R. R.	300	...
New York city, Third Ave. bridge	300	500
Metropolitan R. R., New York	300	...
East River bridge, N. Y. (A. Corbin's)	303	...
City of Brooklyn	400	600
U. S. Govt., Lighthouse Engineer, 1896	300	...
U. S. Govt., Army Engineers, 1896	350	...
U. S. Govt., District of Columbia, 1896	375	500
Sand Test—(3 sand to 1 cement).		
France	...	215
Germany	...	227
Russia	...	142
Belgium	...	215
England (Carey)	...	200
Am. Soc. C. E. recommends	80—125	120—200

Under these recommendations are the following specifications:

	7 days. lbs.	28 days. lbs.
U. S. Govt., Lighthouse Engineers	100	...
U. S. Govt., Army Engineers, 1894	125	...
U. S. Govt., District of Columbia, 1895	100	150
Niagara Falls tunnel	90	...
New York aqueduct	100	...
City of Baltimore	...	150
City of Philadelphia	160	220
U. S. Govt., Lighthouse Engineers, 1896	80	...
U. S. Govt., Army Engineers, 1896	100	...
U. S. Govt., District of Columbia, 1896	125	175

These records all show modern requirements at 7 and 28 days neat, and a swing of the pendulum on the part of government engineers towards lower neat tests.

The reasons for this have been briefly set out in the early part of my letter, as following in the line of the long-time tests of John Grant, of the London drainage, above referred to. His figures from his papers above quoted are as follows; on a section of 2¼ sq. ins. (not 1 sq. in. as now practiced):

Age.	Neat cement. lbs.	1 cement to 1 sand. lbs.
7 days	817.1	353.2
1 month	935.8	452.5
3 months	1,055.9	547.5
6 months	1,176.6	640.3
9 months	1,219.5	692.4
12 months	1,229.7	716.6
2 years	1,324.9	790.3
3 years	1,314.4	784.7
4 years	1,312.6	818.1
5 years	1,306.0	821.0
6 years	1,306.0	819.5
7 years	1,327.3	863.6

These figures, which show about 350 lbs. per sq. in. at 7 days neat corroborate in their long-time continuing gains, the results of tests of cement now used by the New York Aqueduct under a specification of 300 lbs. at 7 days neat.

New York Aqueduct Tests. ("Trans. Am. Soc. C. E.," March, 1893, p. 191.)

Age.	Neat cement. lbs.	1 cement to 2 sand. lbs.
7 days	348	166
1 month	422	280
3 months	540	364
6 months	634	468
9 months	638	468
12 months	682	490
2 years	694	564
3 years	736	680
4 years	771	674
5 years	840	700

That a 300 to 350 lbs. specifications at 7 days neat will give good results the writer thinks is amply substantiated by the figures above given, and this is further corroborated by a paper read a number of years ago before the Institution of Civil Engineers, London, by Mr. Reginald E. Middleton (quoted above), where taking a series of cement tests that had broken at figures between 240 to 300, 300 and 350, 350 and 400, 400 and 450, 450 and 500, and 500 lbs. and over at 7 days neat, he found that those in the first three classes gained largely for a period three years and over, while those in the last three classes showed in the first two cases a slight gain, while in the other case a marked falling off at periods of three years and over, thus proving conclusively that such a specification as Mr. Donaldson recommends of tests of 500 lbs. at 7 days would lead to dangerous results in work.

On the whole, therefore, Mr. Donaldson's specifications may be divided into two classes of subjects. Those which are true are not new, and those which are new are not true.

But for the harm, the expression of such crude and ill-digested specifications as these to the community at large by their publication in scientific journals and their subsequent possible use by inexperienced engineers and architects I would not have trespassed on your columns to such length, nor have gone into so exhaustive an analysis of Mr. Donaldson's paper. It is to prevent this possible harm that I have written and I trust you will pardon the necessary length of my communication.

Robert W. Lesley,
Assoc. Am. Soc. C. E.

22 South 15th St., Philadelphia, Pa., Aug. 7, 1896.

(In accordance with our usual custom we submitted proofs of the above communications to Mr. Donaldson, who has replied as follows:)

Sir: The writer begs to apologize for the delay in answering your favor of the 18th ult., and replying to criticisms enclosed from Prof. S. B. Newberry and Mr. Robt. W. Lesley, as he has been away from the city for several weeks. Taking up the discussion of Prof. Newberry, the writer is pleased to note that this capable authority on cement agrees with him on the importance and need of formulating new requirements, and adopting a more specific system for the testing of Portland cements. Referring to his criticism on quality, to which it is proposed aeration for thirty days, the writer would state that this provision was not made as a guarantee of good quality, but rather to properly regulate the time of setting.

The criticism on chemical composition appears to be well founded. There have been, however, so many specifications drawn up lately, giving the limits of the various elements, showing the wide divergence of opinion on this subject, that it appears necessary to call attention to this and invite discussion. The writer agrees with Prof. Newberry that different raw materials will yield cements of different compositions, for, as he says, the varying composition of clays require different treatment, but would it not be well to establish limits for the several constituent elements and not have so many widely varying limits, which appear to be misleading? Such limits would detect any base properties, or adulterants in the cement. In the requirements for lime, silica, alumina and iron, although narrow, the writer bases his requirements on the average results of the analysis of the best German, French and American brands, with a few Belgian and English cements. Only the highest grade of tri-calcic silicate cements were considered. For magnesia, the reports of the Commission appointed by the German cement manufacturers to investigate the effects of magnesia on cement, made at frequent intervals, in the series of investigations, have gradually increased the permissable percentage since 1891, and in the last report, February, 1895, Drs. Schott, Meyer and Arendt, report the presence of magnesia up to 10% caused no harmful expansion, or cracking even after seven years. Dyckerhoff, as a minority, reported no change with magnesia up to 3%, but recommended the continuance of the allowable 5% limit of the previous year. The Commission agreed to continue the 5% limit, and make further experiments which would show whether a higher limit would be advisable. In the sulphuric acid requirements the writer has been guided solely by the experiments of the German cement manufacturers.

Adhering to the specific gravity test, the writer still thinks this important, as exposing slag and ground silica in adulterated cements, and not so much as determining the relative or apparent density. As to the fineness, the writer's sole intention in establishing such high limits for the No. 100 and No. 200 sieves was to increase the intrinsic value of the cements, and thereby to increase its effectiveness in the work. The prime object in grinding a Portland cement is not only to increase its adhesive strength, but what is of more importance, to cause the mortar to attain its maximum strength in the shortest possible time, which is being looked upon as a principle in high engineering work. From actual experience it has been shown in some of our leading cement manufacturing establishments, there are other mills besides the tube mill capable of producing such a high degree of fineness. Although experience has shown the number of meshes per square inch will vary in a No. 200 sieve, Prof. Newberry is correct in saying that the gage of the wire, as well as the number of meshes to the linear inch, should be specified. The writer has seen and obtained determinations for fineness on a No. 200 sieve, having 200 meshes per linear inch; such a sieve is to be found in the testing laboratory of Messrs. Lathbury & Anderson, Philadelphia. Sieves which do not show 200 meshes to the linear inch are not No. 200 sieves, and if so designated are incorrectly marked by the manufacturers.

In the matter of setting, although the temperature of the air and water do exert an influence on the cement, the writer does not think that in a laboratory, abnormal ranges of temperature, which would materially affect the cement, are likely to occur. It might be well to specify 70° F. for the water, but as to the air, the influence being much less, the writer does not think, in view of summer heats, a limit could be specified. The provision specifying 24-hour tests was made in order to regulate the manner and method of performing same, in view of the various methods put forward in each case where it is specified. Personally the writer is opposed to this test, and thinks seven days the shortest time that should be specified. Recently on quite a large contract, the writer noticed the provision which called for the 24-hour test on Portland cement, one hour in air and 23 hours in water. A Portland cement of this character is inferior in quality. If, as Prof. Newberry suggests, a good quartz sand could be obtained, from some locality and in sufficient quantities, to supply the testing laboratories, in view of the great cost of crushed quartz, it might be well to specify it as standard, instead of crushed quartz. The chief consideration being a uniform sand, which necessarily will give uniform results.

After carefully reading Mr. R. W. Lesley's discussion on standard specifications for cement, the writer was much surprised by its tone, for, instead of being a criticism on technical lines, it delves into personalities wholly unsuited to the high scientific character of your valuable paper. As presumed by Prof. S. B. Newberry, in his interesting criticisms, the writer had no intention to "go it alone" on a subject requiring such careful consideration and deep scientific investigation as the adoption of a new and standard specification for Portland cements, but rather to present the subject in the light of suggestions and thereby open up the scientific discussion which would naturally follow. It is a well-known fact that the recommendations of the committee of the American Society of Civil Engineers are indefinite and altogether incapable of producing uniform results. The requirements are, on the whole, too low and inadequate, which allow of second grade cements going into work where the highest grade Portland cements are intended.

Mr. Lesley has always advocated low standards, following out the English ideas on the subject. Naturally to sustain his argument he introduces the wholly irrelevant subject of the history of Portland cement in England and cites certain well known authorities in that country whose opinions at best are hardly to be considered abreast of the times. It is generally conceded that the continental countries, notably Germany, have made more rapid strides in the investigation and manufacture of cements than in England where Portland cement had its birth. In the conventions held in Munich, Dresden, Berlin and Vienna to promote the adoption of uniform standards and methods for the testing of structural materials, the proceedings of which have been published by Prof. J. Bauschinger, of Munich, and later translated by Capt. O. M. Carter, Corps of Engineers, U. S. A., and Mr. E. A. Giessler, U. S. Assistant Engineer, it appears that the only country conspicuous by its absence was England.

The investigation of the results of long time tests, made on important engineering works in this country, as suggested by Mr. Lesley, would undoubtedly enter largely into the consideration of this subject, but it is doubtful whether any commission or body of experts appointed for such a purpose would pick out the only two works mentioned by Mr. Lesley, namely the New York aqueduct and the Niagara tunnel, admitting, as the writer does, the magnitude of those works, and draw their conclusions on a standard system from the performance noted on the one brand of cement used exclusively on the two pieces of work. As to the process of manufacture, entered into so largely by Mr. Lesley, it does not appear to the writer what connection it may have with the subject under discussion and his energetic defence of the method or "process of manufacture" would appear to the unbiased reader, as though he assumed that his methods of manufacture had been assailed and his equipment for grinding and burning the raw material had become obsolete and altogether incapable of producing a cement which would pass severe requirements drawn up to distinguish between the first and second grade Portland cements. Mr. Lesley apparently overlooks the progress made in the manufacture of Portland cement, and the improvements made in the grinding machinery and methods of burning, all of which are adapted to the various conditions of the materials. With few exceptions the cement manufacturers in this country have made rapid strides and introduced new machinery which would facilitate and at the same time better their product. Taking up Mr. Lesley's criticism on the furnishing by the manufacturer of certified tests, which he characterizes as "work of supererogation," it would be well to explain that this provision was made for the purpose of acting as a guide to those using the cement, whether it was to be tested or not. Such a provision would prevent delays on the work in cases where the cement was to be tested, as from such manufacturers tests it would be shown at once whether the cement was unlikely to pass the prescribed tests.

As to the criticisms on the "chemical composition," the writer has explained his purpose most fully in the discussion by Prof. Newberry, but it might be well to add that the changes noted and made so much of by Mr. Lesley, in the magnesia was a typographical error in the first pamphlet printed. It read 2½% magnesia and should have been 3½% magnesia. Mr. Lesley is wrong in saying that no provision is made for cement to be used in salt water. The second provision for sulphuric acid, calling for ½ of 1% was inserted to cover this contingency.

Throughout Mr. Lesley's discussion appears a vein of facetiousness which is wholly in keeping with the character of his criticisms on such a scientific subject as cement. It appears to the writer unprofessional, claiming as he does to belong to the engineering profession, to question one's reputation in the most insulting language. It appears like a similar attack Mr. Lesley made on Capt. W. W. Maclay some years ago, when the latter gentleman was engineer of the department of docks, New York, and in which he questioned the ability of Captain Maclay to correctly translate an article written in French on the subject of cement. No attempt has been made by the writer to place his authority on this subject against those well known authorities of the world as stated by Mr. Lesley. The subject was brought up for discussion and even Mr. Lesley, "Assoc. Am. Soc. C. E.," is welcome to criticise in the spirit of scientific investigation. The ludicrous attempt of Mr. Lesley to twist the meaning of a sentence in the small pamphlet by the writer of "Alpha Portland Cement," and cited in detail by Mr. Lesley, seems too childlike to answer, but for his benefit it might be well to explain that it was a typographical error in the punctuation.

Under the head of "Fineness" the writer is pleased to note that Mr. Lesley concedes the fact that manufacturers could guarantee the fineness specified and simply cites old specifications to show that no such high requirements were ever asked for, notwithstanding the fact that it is now the best practice among engineers to specify the finest ground cements. The value of fine grinding is known and why should the manufacturer not better the product by almost eliminating the coarser particles which only act as so much sand in the mortar composition.

Mr. Henry Faija, "Portland Cement for Users," London, 1890, says: In the manufacture of Portland cement it is impossible that the clinkers should all be burned to an equal degree of hardness, and in passing through the mill stones it is the softer pieces, or those which have received the least calcination, that are ground finest, and the thoroughly and well-burned clinker is only reduced to granules, not to powder, and as it is the best burned clinker that will produce the best cement, the value of fine grinding of the well-burned clinker is apparent." The writer admits that by increasing the fineness you thereby increase the cost of manufacture and it may be this item which influences Mr. Lesley's criticism on higher standards.

Upon the subject of hot tests Mr. Lesley brings forward authorities who condemn the reliability of this test; but taking up the first country, Germany, he admits that investigations are still being made on its reliability and in the meantime the test is still made. Although Mr. Lesley cites the French Commission's report, conference of engineers Ponts et Chaussees, Cahier Guillain, Service de la Marine, Service de Colonie, in which the "boiling tests" are not included, he does not indicate any of the well-known French authorities as being opposed to this test. In the paper of Prof. H. Le Chatelier, "Tests of Hydraulic Materials" read before the International Engineering Congress, Chicago, Aug., 1893, p. 31, under the heading, "Conclusion," this expert says: "For practical tests, it may be sought to accelerate and exaggerate the expansion due to the slaking of lime. For this purpose it is sufficient to elevate the temperature. If the briquettes, as soon as they have set under water, are plunged into boiling water, the swelling takes place in a few hours, instead of many days, and is besides considerably exaggerated. The products which when cold merely crack disintegrate when hot; those which swell cold split hot: and those which contain too little lime to swell cold do so very distinctly when treated hot. . . . . This test for invariability of volume, when made cold has but little interest, since it detects only exceptionally bad products." Thus it is seen that so eminent an authority as Prof. Le Chatelier, whom Mr. Lesley quotes on other points, thoroughly believes in the "Hot Test." For England he quotes the paper read by Mr. Henry Faija before the International Engineering Congress, Chicago, Aug. 1893, who, although he does not reject the steam vapor or hot-water tests, immerses the specimens in water at a temperature of 116°, thereby showing that he must still have faith in the hot-water test. In quoting his American authorities he states that "U. S. Government, District of Columbia, specifications, 1896, abandons boiling test," without stating on whose recommendation or authority. Next, Mr. F. H. Lewis, of Booth, Garrett & Blair, Philadelphia, who in conjunction with Mr. Edward Whitfield, also of the same firm, made a few experiments on the hot-bath test covering a period less than one year and drew their conclusions from the results obtained. This paper, read before the American Society of Civil Engineers in 1894, appears to be the only contribution on cement literature furnished by Mr. Lewis, whom Mr. Lesley quotes as an authority. From a brief summary of the above it will be seen that the Germans, French and English authorities still adhere to the hot test, while the only two doubtful authorities are quoted for the United States.

Such well-known authorities in this country as Captain W. W. Maclay, Professors Newberry, Spalding and Sondericker still advocate the hot test. Mr. Lesley has always combated this test for possibly the reason that he desires to protect a certain class of cements which cannot meet this requirement.

Taking up the consideration of tensile strength, the writer cannot agree with Mr. Lesley in advocating such low standards. While recognizing the fact that abnormally high tests at short periods of time are not to be desired, the minimum limits advised by the writer are not considered high under scientific testing in well-equipped laboratories, following out societies' rules and regulations. The two principal reasons favoring high tensile requirements are: 1st. In order to keep out inferior and low grade cements. 2d. Maximum strength in short periods of time. Taking up the first reason, laboratory results show that all the best brands of both foreign and American Portland cements will meet the requirements advocated, while the doubtful brands are unable to develop such strengths in the periods of time allotted. Not only the second grade Portland cements, both foreign and domestic, are capable of passing the low requirements of strength in all the European countries and America, as quoted by Mr. Lesley, but even the so-called "Improved" cements, manufactured at some of the American mills and which are neither Portland or Rosendale cements, can pass them. 'Tis true that some of these low grade cements would fail in other requirements than the tensile test, but why should they not be barred in this respect? Considering the second reason, engineers at the present time demand a cement which when used in concrete or mortar will develop a high strength in a corresponding short period of time. This demand has been caused by the rapid growth in this country of massive monolithic structures in which cement is used, and furthered to a greater degree by the necessity of rapid construction, which makes it imperative to concentrate massive weights on concrete footings and on masonry work where cement mortar is used. Rapid hardening coupled with slow setting is desired by engineers in both mortars and concrete. Fine grinding promotes this feature at the same time causing the cement to attain its maximum strength in the shortest period of time.

M. Candlot, "Strength of Cement," Paris, 1891, p. 100, says: "If we observe in a general way the progress in strength of cement gaged neat or mixed with sand, we see that there are two kinds of Portland. Some cements, which give rather low tests during the first period of hardening, finally attain great strength at the end of two months, or even a few years. Other cements, on the contrary, show a very rapid increase in strength, and their maximum is attained in a few weeks or a few months. Nearly all the cements of good quality belong to the second kind; in the first are found the cements of inferior quality.

It is quite evident that, even leaving out the question of quality in the cement, resulting from a more or less careful manufacture, it is preferable to use those cements which acquire a great hardness in a short time. It is always an advantage when the hardening of mortar is not too slow because the structure is thus placed in a short time beyond all dangers. In works in sea water, for instance, a rapid hardening is an essential condition. When testing the cement, the briquettes are kept in pans protected from all causes of deterioration, and this makes it possible for those cements of little strength at the beginning to attain ultimately their maximum strength. But it is not so in practical works, where many outside circumstances are unfavorable to the mortar, and may spoil it more or less seriously, thus preventing it from ever developing all its energy. A mortar will all the more surely attain its maximum hardness as its initial strength is greater.

It is often said that the cements which harden slowly acquire an ultimate strength superior to those cements which attain great hardness in a few days. This is what M. Bonnami has formulated in this way: "What is gained in initial strength is lost in final strength." This is probably true in the case of common cements which contain some ingredients capable of swelling in time, but it is not absolutely true in the case of Portland cements. Whether the hardening is rapid or slow, the final strength is always about the same. "The hardening is gaged neat or when it is mixed with sand. In the first case, the maximum strength is attained in a few months; in the second case the hardening goes on more slowly, and the maximum strength, it appears, is only attained after a few years."

Mr. Lesley cites many specifications, in which with one or two exceptions the requirements for both neat and sand tests are all much below those advocated by the writer. The majority are old specifications whose requirements were favored some ten years ago, when Portland cement as an industry was still in its infancy. No specifications

are quoted among the number from such great users as architects. In the city of Philadelphia alone five of the leading architects, using large quantities of Portland cement, have specifications equally as high as those recommended by the writer while the same can be said of architects in the cities of New York, Boston and Chicago. Mr. Lesley quotes U. S. Government Army Engineers and U. S. Government Lighthouse Engineers as having a single requirement for tensile strength and leads one to believe that cement must pass the same specifications when advertised for from any or all U. S. Engineer Offices. This is a misstatement of facts, for this is one of the principal reasons that led the writer to formulate the "Proposed Standard Specifications for Portland Cement." From the specifications of the U. S. Army and Lighthouse Engineers, nearly all of which are in the possession of the writer, it is to be seen that each has his own individual requirements, thus precluding any single standard requirements as Mr. Lesley leads one to believe. In some of these the requirements are above those recommended by the writer.

Considering the long time tests of John Grant, of the London Drainage Board, Mr. Lesley seeks to place them alongside of the tests made at the present time. They were valuable at the time they were made, but in view of the betterment in quality of all the German manufacturers and a few of the English, these results are useless as a means of comparison at the present time.

To those ignorant of the true facts, the exhaustive discussion by Mr. Lesley appears full of scientific merit. His advocacy of low standards and continued aggressiveness against higher standards is well known; but the writer cannot allow the statement in the latter part of his argument to pass unchallenged. He refers to the harm accruing from such "crude and ill-digested specifications as these to the community at large by their publication in scientific journals and their subsequent possible use by inexperienced engineers and architects." In all fairness to the public, would it not be well for Mr. Lesley to state in what manner the "crude specifications" would prove harmful to "inexperienced engineers and architects?" If Mr. Lesley was writing as a cement manufacturer instead of an "Assoc. Am. Soc. C. E.," possibly these same "inexperienced engineers and architects" might fancy Mr. Lesley was interested in a cement or cements which would not pass the writer's advocated requirements. Let us hope such is not the case and that Mr. Lesley will soon become a convert to the necessity of constantly increasing the quality of American Portland cements and likewise seeing the need of a more uniform and specific standard of tests in this country. Yours very truly,

Wm. J. Donaldson.

Philadelphia, Pa., Sept. 1, 1896.

THE MINERAL WEALTH OF THE UNITED STATES.

From the fourth annual issue of "The Mineral Industry" of the United States and other countries, for 1895, the following abstract is made of some of the more prominent industries tabulated and discussed in this most valuable statistical publication:

The total value of the mineral and metal production of the United States, in 1895, was $678,000,734, an increase of $96,789,496, or 16.6% over the product for 1894. In this total the metals represent $240,617,370, and the non-metallic products, $43,383,364, including in the latter $5,000,000 for various unspecified products. The chief gain has been in the mining of coal and iron ore, in the production of coke, lime, petroleum, evaporated salt, copper, etc., and these gains, as compared with 1894, may be set down as follows:

	1894.	1895.
Coal, anthracite, short tons	52,010,433	58,362,985
Coal, bituminous, short tons	117,865,348	137,398,347
Iron ore, long tons	11,880,000	16,950,000
Coke, short tons	8,495,295	9,927,348
Lime, bbls.	56,750,000	60,000,000
Petroleum (crude), bbls.	48,527,336	50,652,025
Evaporated salt, bbls.	11,798,659	12,521,498
Copper, lbs.	353,504,314	386,453,850
Pig-iron, long tons	6,657,388	9,446,308

The amount and value of gold and silver produced, at the commercial value of the latter, are thus set down for the two years:

	1894. Amount, fine ozs.	1894. Value.	1895. Amount, fine ozs.	1895. Value.
Gold	1,923,619	$39,761,205	2,265,612	$46,830,200
Silver	49,846,875	31,403,531	46,331,235	30,254,286

In 1895, metals to the value of $29,593,543 were produced from foreign ores and bullion, including chiefly silver from Mexico, valued at $18,380,232, gold from British North America and nickel from the Ludbury mines in Ontario; the latter valued at $970,000. The amount of iron smelted from foreign ores is insignificant and not included, while it should be noted that the pig-iron product of the United States, for 1895, exceeds the highest record of any previous year, or 9,202,702 long tons in 1890. This advance again makes this country the leading iron-producing nation of the world; and taking our output as 100, the other leading nations would stand as follows: Great Britain, 79; Germany, 60, and France, 21. Our steel production was over 6,000,000 metric tons, of which approximately five-sixths were Bessemer and one-sixth open hearth steel. The total steel product was 20% greater than that previously reported for any one year.

In the relative importance of mineral products, coal stands first by a standard of value, with a total of 31.8% of the value of the entire mineral productions; and pig-iron holds the second place, with 16% of the total. Gold only represents 6.9% of the total value here referred to; petroleum is next, with 6.3%, and copper holds the fifth place, with 5.5%. Silver production represents only 4.5%, or less than the value of building stone, and but little greater than that of lime, in the column of total values. Among mineral productions petroleum and copper form our chief articles of mineral export. As a mineral producing nation the United States, in 1895, took the first rank as a producer of gold, iron and copper; Mexico exceeded it in the silver output, and Great Britain as a coal producer.

TESTS OF A 300-HP. DE LAVAL STEAM TURBINE.

We have received through the courtesy of Mr. J. W. Lieb, Jr., general manager of the Edison Electric Illuminating Co., of New York, a copy of the results of the acceptance tests of one of the 300-HP. De Laval steam turbines installed in the Twelfth Street station of that company. The results of a six-hour test, made on April 2, 1896, during which independent readings of volt and ampere meters were taken by two observers every five minutes showed a water consumption of 19.275 lbs. per electrical horse-power hour, or 17.348 lbs. per brake horse-power hour, on the assumption that the commercial efficiency of the 100 K-W. dynamos driven by the turbine was 90%.

The turbine tested was one of two supplied to the Edison Electric Illuminating Co., of New York, by the Societe de Laval, both of which were built by the Maison Breguet, of Paris. Each 300-HP. turbine drives, by means of gearing, two 100 K-W. Desrozier's dynamos, one on each side of the turbine shaft.

Operating with a steam pressure of 145 lbs. per sq. in., and a vacuum of 26 ins. the guaranteed steam consumption, when operating condensing, was to be not over 18.7 lbs. per brake HP. hour. The turbine disk has a diameter of about 0.75 meters (29.5 ins.), and a thickness through the blades of about 10 mm. (0.4-in.). The disk runs at a speed of about 9,000 revolutions per minute; the dynamos at 750 revolutions per minute.

The total equipment, comprising steam turbine, gearing and dynamos, occupies a space 4.05 meters (13 ft. 3 ins.) long, 1.97 meters (6 ft. 5⅝ ins.) wide, and 1.31 meters (4ft. 3 ins.) high.

The tests were made under the supervision of Mr. J. Van Vleck constructing engineer of the Edison Electric Illuminating Co. and M. Pare, engineer of the Societe de Laval. The following are the principal results of the six-hour test:

	+ side.	— side.
Average volts	127.25	128.26
Average amperes	708.56	725.47
Deduct amperes field circuit	16.08	16.29
Net amperes	692.48	709.18
Average watts	88,118.10	90,959.40
Average watts, both sides	179,077.5	

This last figure is 90% of 198.475 watts, equivalent to 266.72 brake HP.; horse-power hours, 1,600.32; weight of water condensed and discharged by the air pump in six hours, 27.763 lbs.

Lbs. of water per B. HP. hour	17.348 lbs.
Lbs. of water per B. HP. hour	19.275 lbs.

The uniformity of operation is shown by the five-minute volt and ampere readings. The volts ranged during the six hours from 126 to 128.5, and the amperes from 672 to 765. The vacuum ranged from 25½ to 26 ins, averaging 25.74 ins; the temperature of the inlet averaging 79.7° F., and that of the discharge 103.5° F. The steam pressure averaged 155 lbs. in the pipe, 150 lbs. at the throttle, and 147 lbs. below the throttle. The temperature of the dynamos after the six-hour run was as follows:

	+ dynamo.	— dynamo.
Armature	120° F.	129° F.
Average of fields	98° F.	107° F.
Commutator	144° F.	132° F.
Temperature of room	82° F.	

On April 3 a series of tests was made of the turbine with different loads, when operated with 2, 4, 6 and 7 jets. The duration of each test was one hour. The following are the principal results:

	Average load —amperes— +	Average load —amperes— —	Average —watts.— +	Average —watts.— —	P. c. of full load.	Vacuum.	Lbs. st'm. per E. HP.
2 jets used	153.78	147.15	18,707	18,283	18.50	27.00	27.35
4 " "	433.60	455.80	54,156	57,886	56.02	26.43	20.22
6 " "	700.85	718.65	87,746	91,268	89.51	26.07	19.75
7 " "	771.94	787.33	97,418	100.86	99.14	25.79	19.95

J. F. HOLLOWAY.

In our last week's issue we published a brief note of the death of Mr. J. F. Holloway, the news of which, without any particulars, we received just before going to press. We have since learned that he died at his summer home at Cuyahoga Falls, O., on the evening of Sept. 1. On Aug. 20, while in Buffalo, he took cold, which brought on an attack of congestion of the kidneys. After receiving medical advice to the effect that his condition was serious he hastened home, reaching there Aug. 22. From then until his death he was, for most of the time, in a semi-conscious state.

Mr. Holloway was born in Uniontown, O., Jan. 18, 1825. When about six years of age his father moved to the Western Reserve and built a house on the banks of the Cuyahoga River, where afterward grew the town of Cuyahoga Falls. He served an apprenticeship with the firm of Bill Brothers, engine builders, and then was employed in the shop of the Cuyahoga Steam Furnace Co., of Cleveland. He was for a time in New England, and afterward went to Cumberland, Md., were he was superintendent of a coal mining company for some years. Later he was several years at Shawneetown, Ill., as general manager of an iron and coal company, organized by Sellers & Co., of Philadelphia. About 1860 he returned to the Cuyahoga Steam Furnace Co., at Cleveland, where he remained for 26 years as superintendent and president. This works was one of the most noted of the west for the building of blowing engines for blast furnaces, marine engines for lake steamers and heavy engine work generally. After the death of the old owners of the works Mr. Holloway was its sole guiding spirit, managing it as trustee for the heirs. It was a shop of the olden time, dating from 1834, without the modern appliances considered necessary for heavy work, but nevertheless it continued to do its share of the heavy work for the west until 1886, when the plant was sold entire to the Cleveland Shipbuilding Co. One side of Mr. Holloway's finely rounded character is shown in the address he made to his men on the last day of the year 1886, when the shop was turned over to the new concern. We quote an extract, as follows:

With the closing hours of this, the last day of the year, will come the end of the business of the Cuyahoga works within these walls and under my management. Among the many thoughts which have come to me at the end of over 25 years of my supervision of its business and of my personal association with you none gave me more concern than did the thought what will become of our long-tried faithful men. And nothing gives me more pleasure than the assurance I have received from the new owners that they intend to make no changes in this respect and that they hope every man will continue to occupy his place in the future as he has in the past. As I could not bear the thought that on this last day of the year you should go to your homes and to your families full of doubt and uncertainty as to what might be in store for you in the opening year, so I cannot bear to let this, the last opportunity I shall ever have of seeing you together pass without endeavoring to express to you my appreciation of the fidelity and honesty with which you have all done your part toward making the record of the Cuyahoga Works what it now is. For myself I want to say that working here as a boy and alongside of some who are now present, coming back later on to be your superintendent, and for many years past the president of the company as well, I have had many a difficult task to perform. While it was but just and proper that every man from the lowest to the highest grade should have all that he could earn, it was also necessary that I should have a regard for the interests of those whose money furnished you with employment, and who were entitled to a fair return for its use. Now that all this has come to an end, it is great satisfaction to know that during all these years there has never been a difference between the employees and the company that we could not and did not settle among ourselves, and I hope to the advantage of both.

After leaving the Cuyahoga Works in 1887, Mr. Holloway removed to New York, and was connected with the firm of H. R. Worthington, pump

manufacturers, for seven years as consulting engineer. About two years ago he left this position and became consulting engineer for the Snow Pump Co., of Buffalo, N. Y.

Mr. Holloway was for several terms president of the Civil Engineers Club, of Cleveland; vice-president for two terms of the American Institute of Mining Engineers, and president for the year 1885-6 of the American Society of Mechanical Engineers, of which he was one of the charter members. He was also a member of the Engineers' Club in New York.

While Mr. Holloway was a constructing engineer of marked ability, and a most efficient manager of works, he is best known and will be best remembered by the profession for his remarkable charm of manners and of speech. He was a fluent popular speaker and a ready writer. Probably no member of the profession had a larger circle of intimate personal friends. Another ex-president of the Mechanical Engineers' Society in a private letter says of him: "I think he was the most lovable man I ever knew." The local members of the American Society of Mechanical Engineers at their meeting in Cleveland on Sept. 3 adopted a resolution regarding the personal loss of each of them, caused by Mr. Holloway's death, as well as the loss to the profession at large.. At the next monthly meeting of the Engineers' Club of New York on Oct. 1, addresses of tribute to Mr. Holloway's memory will be made by some of his friends.

A BICYCLE FIRE-ENGINE, propelled by cycling firemen, is being tried in Paris. The engine rests upon two tandem bicycles coupled together and having a single steering post. The engine is simply a rotary pump, operated by the men, and the machine complete, with hose, weighs "only 140 lbs." The pumping power is applied by raising the two hind wheels from the ground, by a supporting leg, coupling the pump to these wheels, and then placing two men in the saddles to do the work. The capacity of the pump is reported as being 4,500 gallons of water per hour, thrown 75 to 100 ft. into the air. It is to be chiefly applied in small towns or in the country.

THE GREENLEAF CENTER-BEARING TURNTABLE.

(With inset.)

The turntable, like all other permanent way and track structures on railways, has had to undergo a material modification in design and construction to suit the increased weight and size of the locomotives which modern traffic demands. In the earlier days of railways, and indeed up to the time not so very many years past, turntable design was not considered a serious problem. For the light weight engines of those times turntables of wood or a combined wood and iron construction amply served all ordinary purposes, for although their lives were short (usually from five to eight years only) they were comparatively inexpensive to repair and replace. The turntable of the present day is quite a different structure, for, constructed as it is of iron or steel from 65 to 70 ft. long and with a capacity of from 100 tons to 170 tons, it is necessarily expensive, and durability in respect to repairs and reconstruction is a very important feature. We find consequently a correspondingly greater attention being given by railway engineers to the careful study of structural principles and constructive details in all parts of such structures. A study of the drawings on our inset sheet with the following description of their more prominent features illustrates the fact very forcibly, and as we shall take occasion to show in a later issue, a similar careful consideration is shown by the work of designers other than the one whose design is illustrated here.

In turntable designing theoretical considerations have to be modified by empirical rules which experience has developed, and before describing the construction illustrated herewith some of these may be stated to great advantage. Theoretically a center-bearing, single beam construction is considered preferable. By this it is meant that the center bearing carries the entire weight of the table and its load leaving the end bearings free from load, and that the whole table acts as a single beam to resist strains. A moment's thought will show that if such a construction can be made theoretically perfect all the frictional resistance to turning is brought at the point where the greater leverage is available to overcome it, and that diagonal deflection with its various concomitant troubles is avoided. Of course, only a more or less close approach to either of these desiderata is possible.

Some of the factors which experience as well as theory have shown to be desirable are the following: (1) Necessarily the tables must be long enough to receive and balance the largest locomotive and tender in use; (2) it should turn easily under all conditions of weather, i. e., snow and ice, and freezing or thawing should not disturb its adjustment or make it turn hard; (3) its wearing bearings need to be of such material and construction as to withstand the load, and not to be disturbed or thrown out of position by shocks or the end thrusts of locomotives entering and leaving the tables; (4) it should swing true to center and preserve its adjustment horizontally and vertically; (5) it should be sufficiently rigid to swing under the heaviest loads with the outer ends of the table clear, and yet be so flexible that the shock of the locomotive will not dangerously strain or perhaps break it; (6) all these features must be obtained with a minimum of first cost and cost in repairs and operation.

How these various requirements come to be demanded will be seen if the operation of the table for the use intended is examined. It must tip to a firm end bearing to receive the locomotive, revert to a horizontal position with both ends clear, when the locomotive is fully balanced on the table, and remain so while the turning is in progress; tip to a bearing at the opposite end when the locomotive leaves the table; and finally revert to its original horizontal position. The variation in the character and intensity of the strains to which the table and its bearings are subjected during these manoeuvres is evident, but it will become definitely apparent if the strain diagram shown by Fig. 1 be examined. This diagram shows the calculable strains in a 65-ft. turntable with a locomotive and tender load of 170-tons, and was calculated by Prof. W. V. Brown, of De Pauw University. Three positions of the live load were assumed: (1) Locomotive balanced over center of table, end rollers not bearing; (2) locomotive moving over one arm of table, and load on other arm neglected; (3) one pair of drivers resting at end of table and remainder of load neglected. Only one side of the engine and table are considered. Of course this diagram does not cover the incalculable strains induced by thrusts and shocks, as these, as in bridge work, are allowed for by excess metal and strength and such construction, as experience has shown to be desirable.

Enough has now been stated to show that the proper design of the center bearing is a problem requiring considerable attention and to show how it has been solved by one designer the improved standard turntable made by the Greenleaf Turntable Co., of Greencastle, Ind., Mr. C. A. Greenleaf, proprietor, is illustrated. Fig. 2 is a general elevation of this table, and Figs. 3, 4 and 5 show details of various parts. Fig. 6 shows the details of a riveted girder table and will be referred to later, but Figs. 2 to 5 will be used to describe the construction and operation. It should be noted that the dimensions given are for a 100 tons capacity table.

The center post A is of cast gun metal 3 ft. 7 ins. high, 15 ins. diameter at the top, 19 ins. diameter at the base, and with flange base 2½ × 2½ ft. square and 4 ins. thick. Near the base is a roller path hardened and ground to a surface 19 ins. diameter and 9 ins. high. At the top is a spherical socket 12¼ ins. diameter, chilled and ground to a true surface and less than a hemispherical segment. In this socket rests a steel sphere, H, 12 ins. in diameter. Sitting over this the center post is a box consisting of a cap B, and a sleeve C, connected by bolts. Both cap and sleeve are cast gun metal. The cap is 26 ins. in diameter, 5 ins. average thickness, faced on the lower side, and having a spherical socket forming the upper bearing for the ball H. The sleeve is 26 × 26 ins. horizontally and 3 ft. 2 ins. vertically. On its outside are four 3½-in. vertical flanges to which the cross struts D are riveted, and at the bottom is an inside annular groove E, 24 ins. in diameter to receive the bearing balls 2 7-16 ins. in diameter. This groove is chilled and ground to exact size, and the bearing balls are of hardened and ground steel.

It will be noticed that the box is substantially prevented from lateral movement at the bottom by the close bearing of the ring of balls, E, and also that the spherical sockets for the ball H are of slightly greater diameter than the ball. The platform of the table is fastened to the cross struts D. Now when the platform tips at one end to receive the locomotive, the ball H rolls slightly toward that end, but as soon as the locomotive is once balanced on the table the ball seeks its original position, or in other words the table becomes horizontal. The tip of the table is of course controlled in amount by suitable end bearing. At the same time that the ball H is rolling to one side and back again the balls E undergo a slight vertical movement. Enough has now been said to show the theory of separation of the center bearing.

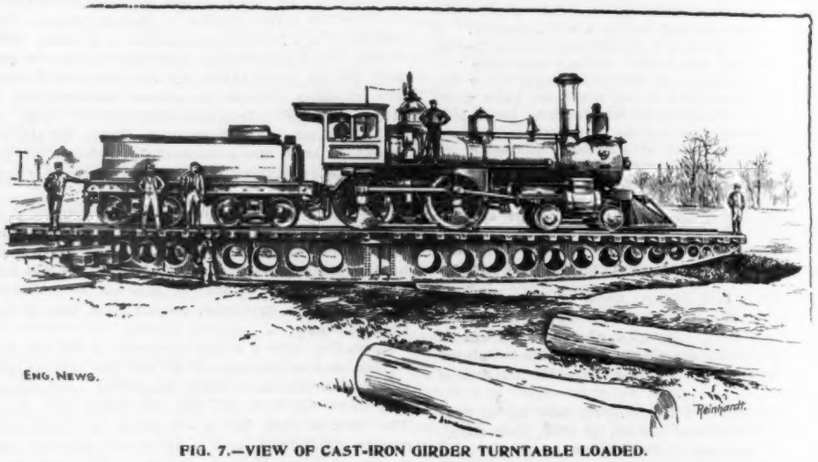


FIG. 7.—VIEW OF CAST-IRON GIRDER TURNTABLE LOADED.

For 60-ft. turntables of 100 tons capacity the builders consider that girders of cast gun metal are preferable, but for tables of greater length or capacity cast gun metal is not so satisfactory. Assuming a table of the above capacity, four girder arms 44 ins. deep at the widest part and 30 ft. long are used. Both the bottom and top flanges narrow in width from the center toward the end of the girder, this taper being from 9½ ins. to 6 ins. for the top flange and from 8 ins. to 4½ ins. for the bottom flange. The thickness of the top flange is 2½ ins., and of the bottom flange 1¾ ins. The girder web is 1⅛ ins. thick at the large end and ⅞-in. thick at the small end, and is perforated with 12 holes of suitable size to relieve the shrinkage strains, but yet to have ample strength. The top flange of the girder is straight but the bottom flange has the line of a parabola.

Two girder arms coupled together at the center

form a single girder for the table. These couplings are made by forged steel tie bars, fitting into suitable sockets cored out of the girder flanges. The atachment of the girders to the center box is shown by Figs. 3 and 4. Besides this lateral bracing there are cross braces about midway of each arm and at the end, and also a cast diagonal bracing. The lock, Fig. 5, consists simply of gun metal castings notched to receive the ends of the girders. The foundation masonry work is sufficiently shown by Fig. 1, and of course this is amenable to modification to suit conditions so long as it is maintained of sufficient solidity and strength.

It will be noticed that the intention of this design in all respects is to conform to the requirements laid down in a previous paragraph. It is entirely center bearing, there being no end rollers at all; by a thorough system of lateral bracing, the whole platform is designed to act as nearly as possible like a single beam; combined rigidity to carry load and flexibility to take up shock is provided by the coupled girders and by the center bearings and perfect and easy adjustment is sought through the ball bearings. In respect to the practical success of this construction toward the end sought we have the statement of the designer who expresses his faith from a long experience in building turntables.

It will be noted that the turntable described has cast-iron girders, but frequently riveted girders of wrought iron or steel are preferred. Fig. 6 illustrates one of these built a few years ago for the Lehigh Valley R. R. This is a 60-ft. table designed for the Lehigh heavy-grade engine, and calculated with the same assumed positions of the live load as is described above in connection with Fig. 1. The structural details are so clearly shown by the drawings that no further description is necessary. It should be noted, however, that the center bearing for which these girders were designed differs considerably from the one illustrated in Figs. 3 to 5, but, of course, this does not affect the girder design except at its connection with the center bearing.

Fig. 7 is a view of a cast girder turntable of the Greenleaf pattern, 66 ft. long and of 120 tons capacity. It will be noticed that the ends swing clear of any bearings when the table is loaded. For the matter from which this and the other illustrations have been prepared we are indebted to the Greenleaf Turntable Co., of Greencastle, Ind.

NATIONAL RAILROAD MASTER BLACKSMITHS' ASSOCIATION.

The fourth annual meeting was held at the Tremont House, Chicago, Ill., September 1, 2 and 3, 1896. The meeting was called to order by President S. Uren (So. Pac. Ry.), of Sacramento, Cal., and the Mayor, Mr. George B. Swift, welcomed the delegates (who numbered 65) to the city. The Secretary, Mr. G. F. Hinkens (St. P. & D. Ry.), read his report, showing a membership of 150, 24 new members having joined at the present meeting. The Treasurer's report showed the following state of finances: Receipts, 1895-6, $464; expenses, $303; balance, $161. The President then read his address.

Report on Forges and Tuyeres.

The common square or round forge, of brick or iron, is good enough for all ordinary blacksmith work. The position of the tuyere, however, varies. Some smiths prefer the old style, solid or hollow for water, which is placed horizontally in the forge, and through which the blast is discharged to the center of the fire. This is not so effective in heating as when the blast enters the fire from the bottom of the forge, through a square iron blast box, which is provided with an opening in the top, fitted with a cast-iron grating having from one to four oblong holes, ⅝ × 2 ins., the grating with a single hole being large enough for very light work. These gratings can be removed and replaced by new ones, though if the blast box is kept clear of cinders and dirt they do not burn out. In the bottom of the blast box is a slide, which, when pulled out, allows all dirt and cinders to be removed. Such blast boxes or tuyeres are the only kind in use in the Southern Pacific shops at Sacramento.

Mr. Looker (Toledo & Ann Arbor) described a tuyere iron used in connection with the round forge. For a deep fire he had a box 12 ins. long, 9 ins. wide, and 5 ins. deep, with a double blast, and a long lid to cover it. In the center of one lid are two slots, ⅝ × 3 ins., and there is another lid with four slots. One lid could be taken off and another put on, according as it was desired to get a long or short heat.

Mr. Coleman (C. & N. W.): We use a common tuyere iron with a cast-iron box underneath. We have the side blast at our common forges, and underneath the tuyere iron we have the box, which is about 7 ins. square, and 6 or 7 ins. deep, with a slide in the bottom, and we find it very convenient in dumping the fire and saving coal. When we come to clean out we do not mix the loose coal with the dirt that drops through. I think we save at least one quarter in coal over the old plan of shovelling out the fires with the solid bottom. There is also a considerable saving in time in cleaning the fires; we clean them in from three to five minutes. I use a double blast also in the big fire, where we weld frames and do large work.

Mr. Robbins (Fitchburg R. R.): I have been using a tuyere having a cone-shaped top, with an oblong hole, about 2 × 1½ ins., with a ball that works into it, fitted with a lever. In the center of the ball is a hole about ¾-in. diameter. When it is desired to run a small fire, by bearing down on the lever, it throws the ball up, closes the large hole, and allows the blast to circulate through the small hole in the ball. At the bottom of the tuyere is a clapper, which we lift out, which allows all dirt and ashes that pass down through the tuyere into the ash box to be cleaned out very readily. The advantage of the cone-shaped top of the tuyere is that all slack and cinders run off below the outlet of the tuyere, which prevents all clogging.

Report on the Best Method of Manufacturing Axles.

To make a good wrought-iron axle we must have a good reverberatory furnace, clean gaseous coal, good scrap, steam hammer, suitable tools and the necessary help required to do the work. Use such scrap as old archbars, bridge plates, bridge rods, small car axles, etc. All scrap should be milled so that no foreign matter remains upon the iron. Cut the scrap into lengths of 18 ins., having piling boards cut from any rejected lumber. Also have a quantity of some iron that is nearest muck iron, such as splice bars, fish plates, etc., well milled and cut to lengths as above, and add about 30% of this muck iron to each pile you put up, well distributed. The slabs will not be so dry and there will be less danger of fire cracks, as the amount of flux will be greater. In piling your scrap use Beattie's system of piling.

The iron so piled and worked into slabs and then into axles will stand severe tests, as the fibers are entwined about each other in such a manner that when the axle is completed it seems almost impossible to break it, provided the iron has been properly heated. Some of our committee favor a two-slab axle, while others favor a three-slab axle, but this is a question that will have to be left with the railway companies that use them to determine what material will be best for a car axle; for the question of the iron axle and the best method of making it so as to give the best service is a matter of tests.

A great many of our leading railways have had made for their own use a muck bar axle under specifications of their own. This axle has proven to be very good and has given good service. The question may be asked: "Why do they want a muck bar axle?" The answer is that we cannot get wrought-iron scrap that is free from steel, as there is so much steel in use now by car manufacturers that it is impossible to get miscellaneous wrought scrap without there being steel scrap in it. You will have more or less soft pieces mixed through the scrap pile and it cannot be detected. So it will be worked and the result will be a weak place inside of the slab. The slabs will be piled together, the axle forged, and you still have the steel in the axle. If the piece of steel gets into a pile of wrought scrap, and the pile is worked into a slab, you will find if you break the slab that the iron has all been worked into one mass, or changed from a lot of small pieces into one piece, but you will find that piece of steel in about the same shape or condition as when it went into the pile. With such contingencies how can we build an iron axle that will stand the M. C. B. test, as was recommended by the committee at the last meeting of that association?

Mr. Mick: In taking scrap iron, old archbars, etc., and making slabs out of these, and putting them into the axle, they are too homogeneous to make a good axle, and he found that it was necessary to put something in there to assist this dry iron, and in the manner of piling it is intertwined in such manner that fire cracks were out of the question, as far as his experience had gone, and he had made a good many axles.

Mr. Williams (C., A. & C.): He would not test an axle in the middle, because that is the best part of it; anywhere from 10 to 18 ins. from the end is the place to test the axle; they always break in that place; he never saw an axle break in the middle from actual wear and tear; anything that breaks an axle in the middle generally breaks up the whole train.

Mr. Judy (B. & S. Car Co.): To say that axles do not break in the center is a mistake; he had seen five axles break inside of one week within 3 ins. of the center, supposed to be first-class axles, both iron and steel. The thing is to prepare an axle that will meet the specifications of the railway companies; they are the people who know whether the axle does the work or not; they discover this from tests and trials in service. Axles will break in the center and in the journal and back of the wheel seat; the companies have found out that the place to test them is in the middle or they would not do it.

Mr. Uren: The center is worked down to a blood red heat, and no iron retains its strength until it is worked to that heat. The end of the axle is finished at a white heat, and then placed in water for the purpose of cooling it. Consequently, the 5-in. part of the axle has not had the same working as the 4¼-in. part, and for that reason it is more crystalline, and my experience is that 25% more axles break at the wheel fit than in the center. Any iron finished at white heat is almost useless.

Mr. Mick: The difficulty arises from the fact that the workman does not have the fire bridge in the proper shape, and the heat is greater where the wheel fit is than it is where the center is, and it becomes fire cracked, and after the axle is in service it will break behind the wheel because the axle was injured in heating.

Mr. Burgess (C. & E. J.): It is almost invariably the journal that breaks. Car axles when running will get overheated and are cooled off with water, and that process goes on, and it is easy to see why the axle breaks at the journal.

Mr. Judy: There are some specifications that call for an axle to be made of muck bar. I know of one company which requires a piece of bar iron right in the middle between two scrap slabs. I do not think you can pile up old rails and work them over the hammer and expect a good job.

Mr. Norris: The greatest percentage of steel axles break in the periphery. It starts on the outside, and gradually breaks down until it comes within an inch of the center, and then it parts, and that occurs when the dead weight comes on the axle in the stopping or starting. There is one thing about steel and iron axles. The M. C. B. requirements say that an iron axle, 4¾ ins. center, shall stand two blows at 15 ft. and three blows at 10 ft. The same axle in steel shall stand five blows without any fracture at 29 ft. If the M. C. B. do not know that steel is better than iron why do they put such specifications for them to fulfill?

Mr. Fitzgerald (C., M. & St. P.): The experience on our road has been that most of the axles break behind the wheel seat. The great objection to the steel axles which are on the road is that they break off quick, whereas the iron axles commence to crack, and the man who examines them has a chance to see the cracks in time to take the axles out, so as to avoid a wreck. I experimented a good deal with scrap last spring, and the result of my experiments was that the best scrap to make axles out of is old coupling links and some round iron to fill in with; it gave the best satisfaction.

Mr. Robbins: I claim an axle will break where vibration ceases and crystalization takes place, which is right back of the wheel fit, provided the wheel is forced up on to the shoulder. On the train on which I came to Chicago they had a hot journal, and when the train stopped the journal was red hot; and the trainmen used eight or ten pails of water to cool it off, and in running the 200 miles the journal was cooled off five times in that way. What condition is that journal in to-day?

Mr. Mould (N. Y., L. E. & W.): I think the day may come when we as blacksmiths may say that a steel axle is better than an iron axle, but I doubt if we are in a position to-day to say so. If a steel axle has been used and run its service what is there left in it for the railway company? With the iron axle we make almost everything on the locomotive. What will you do with the old steel axles?

Mr. Uren: We are manufacturing in the Sacramento shops 30 axles daily, and have been doing so for the last 25 years. We make these axles from ordinary scrap. As to getting steel into the axle, sometimes, undoubtedly, it will get in, but we avoid that as much as possible. The percentage of broken steel axles is far greater than that of iron axles on our road.

Mr. Norris: The company which I represent make more steel axles than any other in the United States. Some railways do not specify what the freight axles shall be made of, but only what the passenger axles shall be made of. One prominent road in the East says that it cannot afford to make any distinction. The only road in the country that can afford to make a distinction is a single track road, where trains are not passing each other continuously.

Report of the Best Methods of Constructing and Repairing Locomotive Frames.

In view of selecting the scrap for frame work, can it be said that we know the condition of this material, or what it contains, or how often it has been reworked? Very evidently in most cases it must be an unknown quality of material. In the selection of scrap much care should be exercised in selecting a good, clear iron free from corrosion to be sheared suitable for piling. Steel and other foreign material should be avoided. In preparing the piles for the heating furnace, muck bar iron should be at hand and mixed in among the scrap, this will increase the amount of slag, making the iron more fibrous. The doubled refined iron is still better than the raw muck bar. The good, sound judgment of a heater is of great importance, as the properties of the iron in the finished state can be rendered useless by the inability of a heater. Likewise with the hammerman; he must understand thoroughly the manipulating of the iron under the hammer to obtain first-class welding. The iron should be handled as quickly as possible, while in a welding state. The hammer should be heavy for shingling purposes, as in the blows alone rendered by the hammer depends the compactness and the welding of the iron; also the removing of any unavoidable foreign substance that may be located in among the iron. No weld should exist or be recommended in the construction of a new frame back. The frame limbs and braces should be forged at the hammer. When the different forgings have been completed at the hammer and the forging in question turned over to the blacksmith for final construction, too much skill cannot be displayed by the workman in welding the different parts together. The fires should be clean, it being most important that every condition necessary for welding should be in the highest state of perfection. This requires that the iron should be at the right welding heat to obtain the required results. A great deal depends, however, in the preparing for the weld. The frame back should be V-shaped at an angle of 45° or 50°, the limb should be split; the angle should be well open in order to secure the union at the apex of the angle, and provision be made for the

necessary amount of stock required to make the weld. The welding should be executed under the steam hammer. In all railway shops of importance, repairing locomotive frames is a frequent occurrence, and to obtain the necessary results, skill and good judgment is required on the part of those supervising the work. Some foremen may be of the opinion that when part of a frame is broken it should be cut out and replaced by a new piece. That this method is economical and good practice is unquestioned, when the frame is not up to the standard dimension, as the case may call for, on account of having been repaired or welded previous, or some other defect. But when the frame is of full size it is quite possible to replace it at an advantage with less expense and quite satisfactory. Very frequently we have a frame broken through the back, the frame being otherwise in good condition; it is quite practical to cut out of the frame a V-shaped section at the point of fracture, making provision for the amount of material it will require for welding. The parts should be firmly clamped together in view of holding them in the proper position. Weld in a piece that has been prepared for that purpose, the frame then turned over and the same operation of welding repeated, and, no doubt, if the proper care is exercised, the repairing of a fracture of this kind will meet with good results. In cases where frames are badly bent or kinked, it requires skill to straighten them in good shape. To do this, it is advisable to cut the brace, then the frame can be straightened to an advantage, and in reweilding the brace, care must be taken in keeping the frame straight.

Report on Furnaces and Fuel.

The soft coal sand bottom furnace has been discussed at a previous meeting, and also the coke furnace, most commonly used in railway shops. The usual forging furnaces are only used in large shops, and then mostly for axles, shingling or heavy forging. Small shops, as a rule, do not have hammer power enough to operate them economically, as it costs from $19 to $22 per day to operate such a furnace, and small shops cannot keep it going. Hence, to be economical, the coke furnace comes into more general use. This furnace may be improved in having an outer wall with 3 ins. space for the circulation of air with a few holes 3 or 4 ins. on the side to make it more comfortable to work at. Water jackets and other methods are used to serve this purpose, but the double wall is preferable. As this era of machine forging is advancing, we all meet the problem, how are we to keep the machine busy? Here is really where the output is gaged. The different locations in which we are placed has somewhat settled what fuel we will use in the great gas belt, in a coal region or oil region. For small furnaces, such as bolt forging or bending on car work, oil is the best fuel both as to economy and efficiency. Some use compressed air to atomize the oil; some only use fan blast of about 6 to 7 ounces per sq. in.; others use steam as an atomizer. The efficiency of oil furnaces is very much improved when the blast pipe is brought in contact with the flame after it has done its work in the furnace. By this means the blast may be heated quite hot, and in that order the oil may be conducted along the steam pipe of the steam hammer. By this method the oil also is heated and becomes very fluid. Various methods are also used for conducting the oil to the furnace. Some use a pressure of air to force the oil to the furnace; if this be done the pressure should not exceed the blast pressure, as the opening of the needle valve is so small when high pressure is used, it is liable to get clogged up. Gravity is in common use, the oil being pumped into a stand-pipe, it being always kept overflowing; 10 or 12 ft. high will generally be head enough. Oil is also a very suitable fuel for spring work. In a spring furnace some prefer to put the burner in the side, others on the end, but in either case there should be a space of about 6 or 8 ins. from the nozzle of the burner to a bevel brick bridge placed so that the oil and blast will strike. This will spray the oil, and then the course of the flame should not be obstructed by square corners, as it will be easily understood that striking squarely into a brick wall will stop its heating capacity. The flame should have a rolling motion, going to every nook inside the furnace and heating it evenly throughout. If the burner be placed on the end the same bevel bridge of brick is used and throws the oil to the roof of the furnace where it strikes a reverse bevel brick, throwing the flame down to the bottom of the furnace, thence along to the small stack 4½ ins. square, 24 ins. high, located about 8 ins. from the opening. A furnace of this class on spring work will run 20 to 24 hours on 50 gallons of oil, and can be kept at the proper heat very easily. Another very good spring furnace is used on spring work on the same principle as the sand bottom soft coal furnace, where soft coal is the fuel wished for. For flue work oil has also been in use in some places, but a small brick fire with feeders for the fuel at both sides is better. The mandril on which the flue is welded enters the furnace so that we do not require to lift the flue out of the fire but only push it through. By this method we have a sleeve or thimble to fit the various lengths and upset against this and the die of the machine, then raising the upper die allows the flue and sleeve to pass to the proper position to be welded. In some places they mix hard coal with coke, but hard anthracite coal is best for this purpose. A certain rolling mill is using gas made from an inferior coal, and this works very well. They have a producer built about 20 or 30 ft. from the furnace into which they put this poor class of coal. They force the fire by steam, driving the gas from this retort or producer to the furnace, which is a large one, having four doors. They run 60 blooms to a heat and 7 heats per day, making some 25 tons of finished iron. They get the fuel for the cost of freight and by this method they can make good iron from fuel that could not be otherwise used.

Mr. Judy: I have seen the oil furnaces working as fine as possible. They say they are doing double the work, and are working the oil with compressed air. I have seen them work their bolt machines in Cleveland, where the oil is carried to the furnace by gravity; also at Altoona. As to the coal furnace, it is nothing more than a reverberatory furnace and works well; but there is more loss of time with coal than with oil. The beauty of the oil furnace is that they can start the furnace and in 20 minutes get a hot furnace; whereas coal furnaces have to be kept going all night. Gas works well after you get the furnace hot, but it takes too much time to get the furnace hot.

Mr. Boyle (C., B. & Q.): We have been using oil in our furnaces for the last six years; furnaces for heating bolts, and also for bending iron and all shapes for car work. We consider them to be much cheaper than either coal or coke. We have an oil furnace which costs from $15 to $20, with which we can turn out four to five thousand ¾-in. bolts in ten hours, at a cost of about two cts. per hundred for fuel. For bending arch bars and all other kinds of car work, we use a furnace that was originally built for soft coal, Indiana block, that used to cost us in the neighborhood of $8 or $10 a day. With the oil we can bend five to six hundred archbars for about $2 cost of fuel. Our oil burners are of our own construction, and cost very little more than the cast iron, with the exception of the patternmaker's time to make the pattern, which will do for all the furnaces. The furnace which we use for bolt making is constructed with four legs, about 25 ins. high, the proper height for a man to stand at, with a common frog plate, 22 × 54 ins., placed on top of the four legs for a foundation body. We have two burners, one in each end of the furnace. The furnace is built on this frog plate. The front of the furnace has one brick standing on end about 9 ins. high. The end of the furnace where the burners come in has one brick laid flatwise, 4 ins. The back of the furnace has one brick laid endwise, and then these bricks are crossed and recrossed up to about 22 or 23 ins., with a top of brick laid edgewise, and compressed with a band of iron 3 × ⅜ in. It is a very cheap furnace and does not cost much to operate.

Report on Machine Forging.

It used to be the rule to forge a piece of work at the hammer and then take it to the blacksmith, who would trim and finish it, allowing about ⅛-in. for the machine to take off. For work that has to be finished in a machine shop, this is an expensive way of doing work, for the very part that the smith took so much pains to make smooth and nice is cut off by the machinist, and the smith's nice work is thrown in the bins as scrap from the lathe and planes cuttings. All this should, and must be done away with if we expect to keep pace with the times and keep our shops up to the standard.

As to locomotive and car forgings, money can be saved by the use of machine tools such as steam hammers, and with plenty of suitable dies much of the work can be completed at the hammer without any blacksmith's labor. Such work will include main rods, parallel rods, T-ends for frame brace, pedestal caps, cross-head guides, cross-head guide yokes, frame clamp and pads, cross frame braces, back and front frame braces, solid links, crow feet, many boiler brace ends, link hangers, valve ends, etc. The majority of these must not go to a blacksmith, except when a weld has to be made. Large sized bolt machines can be used for much light locomotive forgings. Hydraulic forge machines and drop hammers are used in many shops, doing a great amount of work at very low cost.

In car forgings, bulldozers, large bolt forging machines, together with steam and power hammer are indispensable in producing good, cheap work. In fact, we do not know where the work with dies will stop in a car or locomotive shop, for every day develops something new.

At Thursday morning's session the first business was the report of the Committee on "Tool Steel, Tool Making and Dressing." The report was chiefly a discussion of the proper method of tempering steel for tools. Concerning quality of steel it says:

We are now getting as good steel as we ever did, but it is called upon to do from 25 to 40% more work in ten hours than it did formerly. The new machines are now built larger and stronger, and run with increased speed, from which fact the tool must cut off more metal.

Mr. Uren presented a supplemental report, in which he favored one uniformly good quality of steel for all purposes. He said:

We use an enormous quantity of steel; we carry in stock from 40 to 50 tons. We are 2,500 miles away from any steel manufacturer, and it is impossible for us to get special steel for each special job; but if it is a good quality of steel it will answer for almost any purpose. There are cases where we know ahead what we are going to use steel for, such as special sizes of taps, dies and reamers, and we use special steel for those purposes. A good quality of steel should always be used, and it will, in my opinion, answer for almost any purpose. If you use good steel in your tools when they are worn out they will go into something else. We always work our cold steel into something else.

Mr. Uren's ideas were combated by Mr. Burgess, who said:

I would just as soon expect to get one grade of steel to answer all purposes as I would to get one blacksmith that was equally good at spring-making, tool-dressing, and, to carry the thing further, as a frame maker. We have not only one, but quite a number of steel makers in this country that can turn out as good a quality of steel as anywhere on the globe. The American manufacturers have reached a point, where if you will tell them the use for which the steel is intended, they will send you a steel which will do the work satisfactorily.

After an extended discussion on the report on "Tool Steel," in which many differences of opinion were shown, the report of the Committee on "Flue Welding," by Mr. H. G. Finn (West Shore Ry.) was then read, as follows:

On our road we have been butt flue-welding for the past year (since June, 1895). We have about 100 engines on the road with butt-welded flues, and have not had one give out or leak. It is my opinion that it is the best way to weld them. We cut the safe ends 6½ ins. long off No. 10 flues, and our flues are No. 12, cut square off. We put the safe end on the mandril, with the collar about 3 ins. from the end, and they are put in a small furnace. We use hard coke. We butt them together, and when they get hot enough to stick, give the mandril one sharp blow with a 4-lb. hammer. Then it is ready to weld. When the heat comes up give the mandril three good blows with the hammer and it is welded. Then take it out of the fire and swedge it to size. In this way you will make a perfect weld every time, and the flue is full thickness at the weld. In this way we can weld 250 flues in ten hours.

Some discussion followed the report, two of the members believing that butt welding was not as good as scarf welding. We quote the remarks of two members:

Mr. Judy: It has been proven that a butt weld with a tensile strain is all right, but when it comes to vibration it is a question whether it will stand. I believe the butt weld will be a failure, but hope not.

Mr. McLelland: In Colorado, during the past year, we have welded 26,000 flues, which cost us, from the time they were taken out of the boiler until they were put back, an average of 10 cts. each. I went to the shops at Horton, Kansas, last Friday. The flues had been prepared for welding. They were scarfed and put together. The furnace was there, and machine alongside of it. At 8:24 a. m. the man who was welding laid a welded flue on the floor, and at 9:24 there were 110 more welded flues lying alongside of it. The cost of welding flues this month in Horton will be 6.02 cts. I am not certain that it is what would be called first-class welding, but it answers the purpose. There is no doubt that you can weld 100 flues in an hour and not overwork yourself. The fire can be cleaned out in about 20 minutes, and is ready for another 100.

On Thursday afternoon the report of the committee on "The Best Method of Handling and Disciplining a Shop," H. A. Folk (Pennsylvania R. R.), chairman, was read. He said:

In the first place, you do not want too many rules; secondly, do not make any rules that you cannot consistently carry out or that might place you at a disadvantage under some circumstances. Always remember that men have hearts and feelings, that they are just as sensitive to unkind remarks as you are; hence, it is very necessary that when any of your men are taken to task for neglect of duty, that you keep your temper. There is nothing cuts so deeply into the human heart as when a man is corrected for a fault in a kind yet firm manner, unless the man is so hardened that he cannot realize his offense, in which case you have no room in your shop for him. Do not argue any question of discipline with your men; do not become too familiar with your men; make them all your friends, but do not joke with them; many are too apt to presume on your friendship and you also invite too much familiarity. The employee should be made to feel his responsibility; that he is part and parcel of the shop and to a certain extent responsible for its success. Foremen should grade their men and pay them according to grade. If a difference is made and it is properly understood it will be an inducement to the inferior workman to try to improve. In our shop all the work is done on the contract or piecework system. We have an inspector who approves or disapproves of the work and accepts only such as is manufactured properly. The balance is thrown back on the workman's hands and is his loss. As a consequence there is very little iron spoiled, as men do not care to work without compensation. A firm, able, judicious administration will be felt by all of your subordinates, and a foreman who embodies these three principles is a good executive officer.

The next report was that of the committee on "Case Hardening," John Buckley (Illinois Central Ry.), chairman. The report is as follows:

We place the work to be case hardened in a cast or wrought iron box, putting about 2 ins. of granulated raw bone in the bottom of the box, and placing the pieces to be hardened about 2 ins. apart, filling in the vacancies between the pieces until you have covered them with 2 ins. of bone. Then place in the box another layer of work to be hardened, and continue in this manner until the box is full, being careful to have the work on the top of the box covered with not less than 2 ins. of bone; then place a cover on the box, and lute with yellow mud or fire clay. Then put the box in a furnace or open fire (furnace preferred) and subject the box to a strong heat from 8 to 16 hours according to the size of the box, and the bulk of iron to be hardened. Then remove the pieces one by one, clean them with a broom, and chill in clear cold water, and then there will be a uniform coat of steel on the entire surface from 1-16 to ⅛-in., as may be required according to the time it is left in the fire; the longer it is left in the fire the deeper will be the coating of steel.

To case harden large pieces of iron, such as guides and crank pins, it is not necessary to harden the ends of the guides nor the wheel seat end of crank pins. When hardening guides, we cover the ends with a small piece of sheet iron, ¼-in. thick, then fill the ends of the box with sand. The sheet iron will absorb the liquid substance produced by the bone. When the guides have been chilled the ends will be soft. To harden crank pins we place two pins in a box, the wheel seat end of the pins to the end of the box, cover the wheel seat collar of pin with yellow mud, and fill the ends of box with sand, the center with bone. If the pins are large it will require 18 to 20 hours to give them a good coat of steel. After the pins have been chilled we frequently find them sprung and the surface fractured from the effects of being chilled in cold water. We have had good results from pins that after being removed from the box were cooled off in cold blast; the surface in this case will not be hard, but will have a fine coat of soft steel. By this treatment you will not lose any pins, which is frequently the case when they are chilled in cold water Thos. Sheehan, of Erie, Pa., patented a process for case hardening in 1870. We used it for many years and found it a good process when properly prepared. The ingredients are: Salt, sal. soda, charcoal, black oxide of manganese, black rosin and limestone. We have also used Houghton's hydrocarbonated bone black, and found it a first-class article.

The meeting passed a resolution of thanks to the officers, superintendents, superintendents of motive power, master mechanics and master car builders of the various railroads for their assistance in bringing the master blacksmiths together; to the Master Car Builder and Master Mechanics' Associations for their complimentary action with reference to the Association, and to all others who had assisted in making the meeting a success.

The following officers were elected for the ensuing year: President, R. A. Mould, of the Erie R. R.; Secretary and Treasurer, Geo. F. Hinkens, of the St. Paul & Duluth R.R. Chicago was selected for the next place of meeting, and the meeting then adjourned until the first Tuesday in September, 1897.